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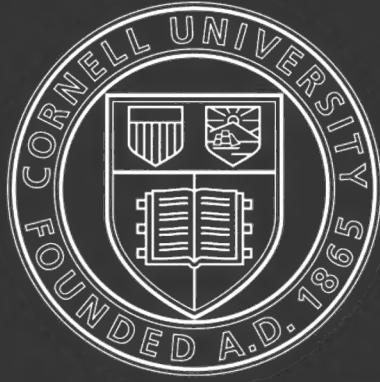
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Palæontologia Indica.

SERIES XVI.

VOL. I

MEMOIRS
OF
THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE
PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR-GENERAL OF INDIA IN COUNCIL.

SERIES XVI.

FAUNA OF BALUCHISTAN AND N. W. FRONTIER OF
INDIA.

VOL. I.

THE JURASSIC FAUNA.

PART 1.—THE FAUNA OF THE KELLAWAYS OF MAZÁR DRIK.

By FRITZ NOETLING, Ph.D., F.G.S.

PART 2.—THE FAUNA OF THE (NEOCOMIAN) BELEMNITE BEDS.

By FRITZ NOETLING, Ph.D., F.G.S.

PART 3.—FAUNA OF THE UPPER CRETACEOUS (MAËSTRICHTIEN)
BEDS OF THE MARI HILLS.

By FRITZ NOETLING, Ph.D., F.G.S.

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By FRITZ NOETLING, Ph.D., F.G.S.,

Palaeontologist, Geological Survey of India.

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PART I.

THE FAUNA OF THE KELLAWAYS OF MAZÁR DRIK.

PREFACE.

THE following memoir opens a new series of the *Palæontologia Indica*, Series XVI, comprising a description of the fossils found in Baluchistán. It is contemplated to publish an account of the rich collections of fossils in a series of monographs, each of which contains the description of the fossils, collected at a certain locality, in certain beds. By adopting this plan it will not only be possible to give further additions, if more and better preserved specimens are discovered at another locality in beds of the same age, without breaking the continuity of the publication, but as each monograph forms a whole in itself, the former drawback of years lapsing before the completion of a monograph will be avoided.

The first part of Series XVI comprises the Jurassic Fauna of Baluchistán, and the present monograph deals with the fauna of the Kellaways from Mazár Drik.

The second part of Series XVI will contain the Cretaceous Fauna of Baluchistán and the first monograph which will appear shortly, and will contain the description of the uppermost cretaceous fauna.

INTRODUCTION.

The oldest formation seen in the sections of the Mari hills of Baluchistán is represented, according to Messrs. Griesbach and Oldham, by a massive limestone which is generally devoid of fossils, or at most contains some ill-preserved fossils here and there; commonest are Brachiopods belonging to the genera *Rhynchonella* and *Terebratula*.

It is clear that these two genera would not have been sufficient to determine the age of the "massive limestone" with certainty, but fortunately Lala Kishen Sing of the Geological Survey discovered a rich fauna of ammonites in these deposits near Mazár Drik. It is, however, to be regretted that almost every specimen has suffered more or less from deformation by pressure, and that the finer structure of the sutural line has been completely destroyed in every case. Under these circumstances the specific determination would have been exceedingly difficult had I not been able to compare this collection with the type specimens from the Jurassic beds of Kutch, which have been so diligently worked out by Professor Waagen. The only fault which I have to find with this fine publication consists in the fact, that the figures of the specimens described do not always represent the original in its actual state, but that they are in many cases considerably, and not always happily, restored. The determination from the figures only, as given in Professor Waagen's publication, is therefore extremely difficult, and it may be noticed that my figures differ considerably from those of the species of the same name as shown by Professor Waagen. I have, however, convinced myself by actual comparison with the Kutch originals that the specimens here described under specific determinations attributed by Professor Waagen to forms from Kutch, are really identical with these species, notwithstanding the apparent difference of the figures. In two cases, however, I felt under an obligation to reproduce two of Professor Waagen's originals, in order to prove to the reader the identity of the Baluchistán forms with those from Kutch, as the published figure of the Kutch species differs considerably from the type specimen. The Jurassic limestone of Mazár Drik has up to the present yielded 22 species, of which 17 have been determined specifically, while of 5 only the genus could be determined. Out of the 17 species specifically determined, 16 could be identified with species already described, while one form, *Perisphinctes baluchistanensis*, could be recognized as new.

The 22 species mentioned represent the following classes:—

| | | | |
|--------------------|----|---------|--------------------------------|
| <i>Brachiopoda</i> | 2 | species | (two specifically determined). |
| <i>Pelecypoda</i> | 3 | „ | (none „ „). |
| <i>Gastropoda</i> | 1 | „ | (none „ „). |
| <i>Cephalopoda</i> | 16 | „ | (15 „ „). |

It will be seen that the *Cephalopoda* far exceed the other classes in number of species, and amongst them the *Ammonoidea* are represented by a much larger number of species (12) than the *Nautiloidea* (3).

The following is the list of the *Cephalopoda* here described :—

1. *Nautilus wandaensis*, Waagen.
2. „ *giganteus*, d'Orbigny.
3. „ *intumescens*, Waagen.
4. *Harpoceras* sp.
5. *Sphæroceras bullatum*, d'Orbigny sp.
6. *Macrocephalites macrocephalus*, Schloth. sp.
7. „ *transiens*, Waagen.
8. „ *polyphemus*, Waagen.
9. „ *subcompressus*, Waagen.
10. „ *lamellosus*, Waagen.
11. „ *grantanum*, Waagen.
12. „ *opis*, Waagen.
13. *Perisphinctes balinensis*, Waagen (non Neumayr).
14. „ *baluchistanensis*, spec. nov.
15. „ *recuperoi*, Gemmellaro.
16. „ *aberrans*, Waagen.

The above list shows at once that the genus *Macrocephalites* preponderates in number of species over all the other genera, a fact which is in itself sufficiently significant. As however 15 species have been identified, we are able to determine the horizon of the “massive limestone” with considerable certainty. The 15 species which have been identified with specimens described from Kutch, occur there in the following horizons :—

- | | | | | | |
|---|---|---|---|---|---------------------|
| 1. <i>Nautilus wandaensis</i> , | . | . | . | . | Dhosa Oolite. |
| 2. „ <i>giganteus</i> , | . | . | . | . | Macrocephalus-beds. |
| 3. „ <i>intumescens</i> , | . | . | . | . | Macrocephalus-beds. |
| 4. <i>Macrocephalites macrocephalus</i> , | . | . | . | . | Macrocephalus-beds. |
| 5. „ <i>transiens</i> , | . | . | . | . | Dhosa Oolite. |
| 6. „ <i>polyphemus</i> , | . | . | . | . | Dhosa Oolite. |
| 7. „ <i>subcompressus</i> , | . | . | . | . | Macrocephalus-beds. |
| 8. „ <i>grantanum</i> , | . | . | . | . | Macrocephalus-beds. |
| 9. „ <i>opis</i> , | . | . | . | . | Anceps-beds. |
| 10. <i>Perisphinctes balinensis</i> , | . | . | . | . | Macrocephalus-beds. |
| 11. „ <i>recuperoi</i> , | . | . | . | . | Macrocephalus-beds. |
| 12. „ <i>aberrans</i> , | . | . | . | . | Athleta-beds. |

The above list is a sufficient proof that the “massive limestone” of Baluchistán, for which I propose the name of “*Polyphemus*-limestone” from the frequent occurrence of the enormous species of that name, is equivalent to the Charee-group of Kutch, inasmuch as not a single species of the younger Katrol group is represented amongst the specimens from Baluchistán.

The older Putchum group has only yielded *Macrocephalites macrocephalus*, but inasmuch as this species has its chief development in the Charee-group of Kutch I do not think this affects the case, and we may assume that the *Polyphemus*-limestone of Mazár Drik really represents the Charee-group of Kutch, and it only remains to determine which subdivision of the Charee-group the *Polyphemus*-limestone is likely to represent.

Professor Waagen has divided the Charee-group into four sub-divisions which in descending order are as follows :—

4. Dhosa Oolite.
3. *Athleta*-beds.
2. *Anceps*-beds,
1. *Macrocephalus*-beds.

From the above list it will be seen that seven species, *viz.*,—

Nautilus giganteus
 „ *intumescens*
Macrocephalites macrocephalus
 „ *subcompressus*
Perisphinctes balinensis
 „ *recuperoi*
 „ *grantanum*

characterize the *Macrocephalus*-beds in Kutch, three species, *viz.*,—

Nautilus wandaensis
Macrocephalites transiens
 „ *polyphemus*

occur in the upper subdivision, the Dhosa Oolite of Kutch, while the intermediate *Anceps* and *Athleta* beds are represented each by one species, *viz.*,—

Macrocephalites opis

in the *Anceps* beds and

Perisphinctes aberrans

in the *Athleta* beds.

Although the distribution of the species as shown above gives no absolute proof, the greater majority of the species are represented by those forms which are characteristic of the *Macrocephalus* beds in Kutch. Until this is disproved, we must consider the *Polyphemus*-limestone to be the representative of the *Macrocephalus* beds in Kutch and to be homotaxial with the lower Kellaways beds of Europe.

The evidence afforded by the two species of Brachiopods together with *Sphæroceras bullatum*, d'Orb., which seem to indicate a somewhat lower horizon, *viz.*, Inferior or Great Oolite, is not at present sufficiently strong to affect the above view.

Future examinations will, I trust, decide whether the *Polyphemus*-limestone of Kutch is capable of being subdivided into divisions similar to those of the Charee-group of Kutch.

THE FAUNA OF THE KELLAWAYS OF MAZAR DRIK IN BALUCHISTAN.

I.—MOLLUSCOIDEA.

Class : BRACHIOPODA, Cuvier.

Sub-class : ARTHROPODATA, Owen.

Order : *TELOTREMATA*, Beecher.

Sub-order : ANCYLOBRACHIA, Gray.

Family : *TEREBRATULIDÆ*, Gray.

Sub-family : *TEREBRATULINÆ*, Dall.

Genus : *TEREBRATULA*, Llhwyd.

TEREBRATULA VENTRICOSA ZIETEN. Plate I, fig. 1-1*b*, 2-2*a*, 3-3*b*.

(Synonyms : *Paléontologie française*, Terrain jurassiques, Brachiopodes, p. 260, pl. 73, fig. 2, pl. 74, 76.)

| | | | | | | | | | | | | |
|-------------|---|---|---|---|---|---|---|---|---|---|---|--------|
| Dimensions. | | | | | | | | | | | | |
| Length | . | . | . | . | . | . | . | . | . | . | . | 37 mm. |
| Breadth | . | . | . | . | . | . | . | . | . | . | . | 26 " |
| Thickness | . | . | . | . | . | . | . | . | . | . | . | 18 " |

The oval shell is considerably longer than broad, its greatest breadth being towards the middle of the length. Both valves are somewhat inflated near the cardinal margin, and depressed towards the frontal region. Beak thick, rounded and truncated with a large foramen, deltidium small, almost hidden by the prominence of the beak, lateral ridges indistinct. Marginal line slightly curved and raised in front.

Surface smooth, showing only irregular striae of growth, but occasionally numerous longitudinal striae are visible, due to shell structure.

Locality and stratigraphical position.—Mazar Drik and Sembar Pass, *Polypheumus*-limestone.

Remarks.—This species is very common at both localities, but it seems that it never attains a particularly large size. Apparently the mesial fold of the ventral valve varies but little, and generally remains rather flat.

The specimens from Baluchistan agree in their shape so well with Deslongchamps' fig. 2, or with Davidson's *Terebratula buckmani*, var. *buckmaniana*, that I have not the slightest doubt that they must be referred to either one or other of these species, unless M. Deslongchamps' view that both forms are identical is accepted. I fail to discover any difference between these two species, and therefore fully agree with M. Deslongchamps, who considers *Terebratula buckmani*, Dav., to be identical with *Terebratula ventricosa*, Ziet.

Sub-order: ROSTRACEA, Schuchert.

Family: *RHYNCHONELLIDÆ*, Gray.

Genus: *RHYNCHONELLA*, Fischer de Wald.

RHYNCHONELLA *PLICATELLA*, Sow. sp. Plate I, fig. 4—4*b*, 5-5*b*.

(Synonyms: Davidson, Monograph of the British Fossil Brachiopoda, Part III, Oolitic and Liasic Brachiopoda, p. 86.)

Dimensions.

| | |
|---------------------|--------|
| Length | 35 mm. |
| Breadth | 33 „ |
| Thickness | 24 „ |

The sub-globose shell is of sub-trigonal shape, being slightly higher than wide. The ventral valve is moderately, the dorsal valve highly, inflated; front semi-circular; the beak is short but acute and rather depressed, foramen small, beak ridges sharply marked, false area shallow. The mesial fold and the sinus are very indistinctly shown and almost level with the lateral parts of the valves. Surface covered with a variable number of very regular rounded ribs.

Locality and stratigraphical position.—Mazár Drik and Sembar Pass, *Polyphe-mus*-limestone.

Remarks.—The specimens from Baluchistán agree so well in character with the abovenamed species that I have no doubt as to their identity; they show particularly well the highly convex ventral valve, and a comparatively, flat depressed dorsal valve. Like the European type, *Rhynchonella plicatella* from Baluchistán varies very little in its general shape, except that in some specimens the sinus is perhaps somewhat deeper than in others.

II.—MOLLUSCA.

1. Class: PELECYPODA, Goldfuss.

1. Order: *ANISOMYARIA*.

Sub-order: PECTINACEA.

Family: *LIMIDÆ*.

Genus: *LIMA*, Brug.

LIMA [*PLAGIOSTOMA*?] sp. Plate I, fig. 6.

This genus is probably represented by an obliquely trigonal, rather flat shell of moderate size. The surface is covered with numerous strong, rounded, radiating ribs which seem to be somewhat narrower than the interstices which separate them; excepting some fine concentric striae of growth, which are seen here and there, the ribs are probably smooth. Only the anterior ear is visible; it is, however, very small and indistinctly detached.

Locality and stratigraphical position.—Mazár Drik, *Polyphemus*-limestone.

Remarks.—Although fairly common, none of the specimens are well enough preserved to permit of a specific determination. To judge from its general feature, this species seems to be closely related to *Plagiostoma semi-circulare*, Goldf., from which, however, it is apparently distinguished by much coarser ribs.

Sub-order : MYTILACEA.

Family : AVICULIDÆ.

Genus : GERVILLIA, Defr.

GERVILLIA sp.

A few fragments of an elongated shell probably belong to this genus. But they are too badly preserved to allow of further determination. The left valve is transversely elongated and slightly inflated, the right valve is flat and somewhat concave towards the dorsal margin. If any conclusion can be drawn from such fragments it may be said that in general shape this species seems to be related to *Gervillia aviculoides*, Sow.

Locality and stratigraphical position.—Mazár Drik, *Polyphemus*-limestone.

2. Order : DESMODONTA.

Family : PHOLADOMYIDÆ, Desh.

Genus : PHOLADOMYA, Sow.

PHOLADOMYA sp. Plate I, fig. 7.

This genus is represented by a very much deformed specimen of apparently rectangular shape. Anterior portion very short, posterior side elongated. Beaks low, depressed, very near the anterior margin. Surface covered with 13 radiating fine ribs, which are apparently closer together on the anterior than on the posterior side.

Locality and stratigraphical position.—Mazár Drik, *Polyphemus*-limestone.

2. Class : GASTROPODA.

Order : PROSOBRANCHIATA, Cuv.

Sub-order : ASPIDOBANCHIATA.

Family : PLEUROTOMARIIDÆ.

PLEUROTOMARIA sp.

The only representative of the gastropods which has been found, is the cast of a tolerably large trochiform shell, which probably belongs to this genus. It consists

of more than five low, flat whorls, which increase very slowly in height and are separated by a deep suture. The base is flat, the umbilicus narrow.

Locality and stratigraphical position.—Mazár Drik, *Polyphemus*-limestone.

Remarks.—In the absence of any distinguishing features I refrain from any references to species hitherto known.

3. Class: CEPHALOPODA,

1. Sub-class: NAUTILOIDEA.

Family: NAUTILIDÆ.

Genus: NAUTILUS, Breyn.

NAUTILUS WANDAENSIS, WAAGEN. Plate II, fig. 1-1a.

1875. *Nautilus wandaensis*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 17.

| Dimensions. | I. | II. |
|--|-----|-----|
| Diameter of shell | 135 | 100 |
| „ of umbilicus | 14 | 12 |
| Height of the last whorl from the umbilical suture | 77 | 54 |
| „ „ „ from the preceding whorl | 54 | 45 |
| Thickness of last whorl | 77 | ? |

Whorls rather low, but broad; general shape very involute with very narrow umbilicus. The whorls are thickest near the umbilical margin, and have flat sides which slope very gradually towards the ventral side; the latter is flattened, with obtuse edges. The septa are simply curved and cut out on the ventral side. The siphuncle is eccentric and nearer the ventral side.

Locality and stratigraphical position.—Mazár Drik, *Polyphemus*-limestone.

Remarks.—In general shape this species closely resembles *Nautilus giganteus*, d'Orb., but it can be easily distinguished from this species by its smaller umbilicus; the position of the siphuncle forms also a distinguishing feature, as in *Nautilus giganteus* it is closer to the dorsal, whereas in *Nautilus wandaensis* it is nearer to the ventral side.

Professor Waagen founded this species on two specimens, of which only one, however, the original of pl. IV, fig. 3a, b, can be traced in the collection of the Geological Survey Department. The sutural lines are not visible on this specimen, the drawing of which is considerably restored; the whole of the upper part of the right side of fig. 3, b, is restored, so that the cross section is therefore by no means so clearly seen as one might be led to believe from the figure.

The specimens from Baluchistán, although considerably larger than one of Professor Waagen's type specimens, agree so well with that form that I have no doubt that they are identical. They are alike not only in general shape, but also

in having a small umbilicus, and a flattened ventral side, which, however, is not quite so flat as in *Nautilus giganteus*, but is slightly rounded.

Professor Waagen states that this form is closely allied to *Nautilus calloviensis*, Oppel, but differs from it by a much larger umbilicus. Having the originals of both of Professor Waagen's types before me, I think I should have taken another view, because the original of *Nautilus calloviensis* is a fragment, only half the size of *Nautilus wandaensis*, and it might perhaps be assumed that, if fully grown, would possess an umbilicus of the same diameter as *Nautilus wandaensis*.

NAUTILUS GIGANTEUS, d'Orbigny. Plates IV and V.

1842. *Nautilus giganteus*, d'Orbigny, Paléontologie française. Terrains jurassiques, Vol. I, p. 163, pl. 36.

1825. *Nautilus giganteus*, d'Orbigny, Annales des sciences naturelles, Vol. 5, pl. 6, fig. 2.

1826. *Nautilus hexagonus*, Sowerby, Min. Conch., Vol. VI, p. 55, pl. 529.

1875. *Nautilus kumagunensis*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 19, pl. III, fig. 1a, b.

| | Dimensions. | I. | II. | III. |
|--|-------------|-----|-----|------|
| Diameter of the shell | | 223 | 222 | 155 |
| „ of the umbilicus | | 47 | 40 | 30 |
| Height of the last whorl from the umbilical suture | | 110 | 121 | 91 |
| „ „ „ from the preceding whorl | | ? | 93 | 68 |
| Thickness of the last whorl | | 145 | 142 | 102 |

Whorls thick, but comparatively low; slightly compressed laterally; ventral side flatly concave and bounded by obtuse margins. Whorls thickest near the umbilical margin; and sloping gradually towards the siphonal side, but dropping steeply towards the umbilicus. The latter is very narrow and deep, the umbilical margin rounded, and the umbilical wall almost perpendicular.

The siphuncle is eccentric and nearer the dorsal side.

The septa are simply curved but rise considerably at the ventral side, where they are strongly cut out in the middle.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—If we consider with d'Orbigny the slightly excavated ventral side, and the very slightly sinuous sutures as the characteristics of *Nautilus giganteus*, then it is quite clear that this form must be united with *Nautilus hexagonus* Sowerby. On the other hand, I can see no points of difference between *Nautilus kumagunensis*, Waagen, and *Nautilus hexagonus*. This form has been founded by Waagen on a single specimen, which apparently represents a young individual. I think that it cannot be separated from *Nautilus hexagonus*, Sow., as the ridges on either side of the siphonal side are sufficiently developed to indicate that type. Nor do I think that any conclusion could be drawn from it as regards the size of the umbilicus of a full-grown specimen, for, as I have already said, Professor Waagen's specimen is apparently a young one. It certainly exhibits the same characters as the enormous specimens from Baluchistán which undoubtedly show a fairly wide umbilicus. For this reason I have considered it identical with *Nautilus hexagonus*, Sow., which again is identical with d'Orbigny's *Nautilus giganteus*.

I may mention here that Professor Waagen's fig. 1-*b* is considerably restored; the right upper half is wanting, and the posterior portion of the last whorl is somewhat crushed; the original is therefore by no means so regular as depicted.

NAUTILUS INTUMESCENS, Waagen. Plate III, fig. 1-1*α*.

1875. *Nautilus intumescens*, Waagen, Palæontologia Indica. Jurassic Fauna of Kutch, Vol. I, p. 20, pl. III, fig. 3 a-b.

Dimensions.

| | |
|--|---------|
| Diameter of the shell | 227 mm. |
| „ of the umbilicus | ? |
| Height of the last whorl from the umbilical suture | 118 mm. |
| „ „ „ from the preceding whorl | 93 „ |
| Thickness of the last whorl | 142 „ |

As will be seen from the above measurements, which represent a shell without body-chamber, this species attains a considerable size. The shell consists of highly inflated, rounded whorls which do not overlap each other completely, but leave a comparatively wide umbilicus. Whether the umbilicus was covered by a shelly callosity as in Professor Waagen's original, cannot be decided, the specimen under examination being a cast; it must, however, be stated, that the umbilicus is entirely filled out, but whether by matrix or not, it is impossible to say. The whorls attain their greatest thickness just above the umbilical edge and slope from there in a gradual curve towards the rounded ventral side. Siphuncle sub-central, but somewhat nearer the dorsal side.

Sutural line simple, very slightly cut out on the ventral side.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is easily distinguishable from the two other forms by its inflated whorls, exhibiting rounded sides and a rounded ventral side. It is by this last feature that this species may be most readily distinguished.

Although much larger than Professor Waagen's original, I think that the specimen from Baluchistán must be united with *Nautilus intumescens* from Kutch. Both forms agree so well as regards the rounded whorls and the generally inflated shape of the shell that I see no reason why they should be considered as different species. The only difference, if difference it can be called, which I can find, is that it is impossible to decide whether in the form from Baluchistán the umbilicus was open or covered with a callosity, as it unquestionably was in *Nautilus intumescens*, Waagen. This question must be left open for the present, and unless better preserved specimens should prove that the umbilicus remained open, this form must, according to the general shape of the shell, be considered as identical with *Nautilus intumescens* from Kutch.

Professor Waagen has drawn attention to the close affinity between *Nautilus intumescens* and *Nautilus inflatus*, d'Orbigny. In this I fully agree with him, but I may add that, notwithstanding their great similarity, both forms can be distinguished by the position of the siphuncle. If d'Orbigny's figure exhibits this feature

correctly, the siphuncle is closer to the ventral side in *Nautilus, inflatus*, while it is nearer the dorsal side in *Nautilus intumescens*.

2. Sub-class: AMMONOIDEA.

Order: AMONNITIDÆ.

Sub-order: ANGUSTISELLATI, Branco.

Division: LANCEOLATIFORMES.

Family: ÆGOCERATIDÆ, Steinm.

Part I: Carinati, Steinm.

1. Sub-family: HARPOCERATINÆ, Steinm.

HARPOCERAS, sp. Plate VI, fig. 1.

The assumption of the occurrence of this genus in the limestones of Mazár Drik is based on the discovery of a medium-sized fragment, which I think exhibits a sufficient number of characters to permit of generic determination. The shell consisted of very high whorls, laterally much compressed and with a sharp siphonal side. The umbilicus is very narrow. The sides are covered with low, rounded, S-shaped ribs which divide sometimes into two, sometimes into three branches.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—There is no species, among those from Kutch, with which the above specimen could be compared. It differs from all of them by its strongly compressed whorls, and its rather faint ribs. As it is, however, too badly preserved, I refrain from identifying it with any European species, trusting that future researches may perhaps bring more material from which a definite conclusion might be drawn.

Part II: ANNULATI, Steinm.

1. Sub-family: STEPHANOCERATINÆ, Steinm.

1. Genus: SPHÆROCERAS, Bayle.

SPHÆROCERAS BULLATUM, d'Orbigny. Pl. VI, fig. 2-2a.

1845. *Ammonites bullatus*, d'Orbigny, Pal. Française Terr. Jur., p. 412, pl. 142, figs. 1 and 2.

(Non *Stephanoceras bullatum*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 129, pl. XXXII, fig. 1 a, b.)

Dimensions.

| | |
|--|---------|
| Diameter of the shell | 152 mm. |
| „ of the umbilicus at the end of the body-chamber | 37 „ |
| „ „ „ „ beginning of the body-chamber | 13 „ |
| Height of the last whorl at the end of the body-chamber | 43 „ |
| „ „ „ „ beginning of the body-chamber | 61(F) „ |
| Thickness of the last whorl at the end of the body-chamber | 60 „ |
| „ „ „ „ beginning of the body-chamber | 88 „ |

The sub-globose shell consists of rather low but highly inflated whorls, which exhibit a considerable deviation from the regular spiral line after the shell has attained a certain size. They increase slowly in height and rapidly in thickness apparently, till the beginning of the body-chamber, when they begin to decrease slowly in height but very quickly in thickness, so that the transverse section of the mouth of the shell is much narrower than that of the whorl at the beginning of the body-chamber. The umbilicus is therefore elliptical in cross section, exhibiting an irregular-shaped portion of the preceding whorl. The umbilical wall is rather steep, and the sides pass gradually into the broad rounded siphonal side. The ornamentation consists of flat rounded ribs, which are single at the umbilical edge and divided into two or three branches on passing over the siphonal side.

The length of the body-chamber is about three quarters of a whorl.

Sutural line not visible.

Locality and stratigraphical position.—Sembar Pass; *Polyphemus*-limestone.

Remarks.—There is only one specimen from Baluchistán, but in ornamentation and general features of the shell, it bears such a close resemblance to d'Orbigny's figure, that I have not the slightest hesitation in identifying it with the above-quoted species.

On the other hand, it differs considerably from the Kutch form, which Professor Waagen has named *Stephanoceras bullatum*, d'Orbigny. A comparison of the two front views of the *Stephanoceras bullatum*, from Baluchistán, and *Stephanoceras bullatum*, Waagen, from Kutch, reveals striking differences. In the first-named species the greatest thickness of the whorls is exhibited at the beginning of the body-chamber, just a little in front of where the aperture rests on it. In the second species (Waagen's fig. 1-b) the centre of the body-chamber approximately marks the greatest thickness. Therefore in Professor Waagen's figure 1-b, two tangents on either side of the last whorl would converge towards the aperture, while in the Baluchistán specimen they would diverge from it. The same difference exists between d'Orbigny's original of *Ammonites bullatus* and Professor Waagen's *Stephanoceras bullatum* from Kutch. Professor Waagen has apparently noticed this difference, for he says: "though I am not sure if the specimens figured by Quenstedt and Gemmellaro, with which the Indian form principally agrees, are in reality the same species as that which was understood by d'Orbigny to be *Ammonites bullatus*, yet I cannot make a distinction."

If, however, the specimen from Kutch is compared with that from Baluchistán it is obvious that the two forms cannot be considered as representing the same species. On the other hand, the species from Baluchistán agrees with regard to the abovementioned feature much more with d'Orbigny's *Ammonites bullatus* than does the specimen from Kutch. I think that it would have been preferable to give the latter a new name instead of identifying it with a form from which it is distinguished by such marked features.

In the absence of sufficient material I do not intend to attempt to decide the question as to whether Quenstedt's *Ammonites bullatus* is in reality identical with

d'Orbigny's *Ammonites bullatus*; a comparison of the figures leads to the conclusion that they represent different species. All I wish to state here is, that the form from Baluchistán certainly differs from Quenstedt's *Ammonites bullatus* as regards the general shape, and that I am doubtful as to whether the relationship of that species with the form from Kutch is so close as Professor Waagen supposes it to be.

2. Genus: MACROCEPHALITES, Sutn.

MACROCEPHALITES MACROCEPHALUS, Schlotheim. Pl. VII, fig. 1-1a, Pl. VIII, Plate IX, fig. 1.

1875. *Stephanoceras macrocephalus*, Waagen, *Palæontologia Indica, Jurassic Fauna of Kutch*, Vol. I, p. 109, Pl. XXV, Pl. XXVII, fig. 1, a. b. (non c) Pl. XXXIII, fig. 5.

| Dimensions. | | | | | | | | I. | II. |
|--|---|---|---|---|---|---|---|--------|-----|
| Diameter of the shell | . | . | . | . | . | . | . | 210 | 116 |
| „ of the umbilicus | . | . | . | . | . | . | . | 22 | 17 |
| Height of the last whorl from the umbilical suture | . | . | . | . | . | . | . | 123 | 64 |
| „ „ „ from the preceding whorl | . | . | . | . | . | . | . | 70 (P) | 50 |
| Thickness of the last whorl | . | . | . | . | . | . | . | (P) | (P) |

The shell consists of rather compressed moderately high whorls which so completely overlap each other that only a very narrow umbilicus remains. The sides are flat and slope from the umbilical edge towards the rounded siphonal side. As the whorls are laterally compressed and increase only slowly in height the cross-section is elliptical in shape.

The sides are covered with numerous, very regular fine polytomous ribs, of which the stems are always effaced in the neighbourhood of the umbilicus, the ribs pass in a straight line over the siphonal side, where they follow each other at equal intervals, which are somewhat broader than the ribs themselves. On large specimens the ribs completely disappear on the body-chamber. The body-chamber is apparently not large, its length being about three quarters of the last whorl. Towards the aperture the body-chamber deviates from the regular spiral, the umbilicus becoming slightly wider while the mouth is contracted.

Sutural line very indistinct.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—Professor Waagen mentions that the chief variations of this species consist in the differences of the transverse diameter of the whorls and the number of ribs. The specimens under examination are too ill-preserved to allow of any definite statements as to the number of ribs, but as regards the transverse diameter it seems that they are generally somewhat more compressed than the specimens figured by Professor Waagen. I have before me his originals, and a careful comparison of the two forms shows that the Baluchistán forms have less inflated whorls than those of Kutch, the cross-section is therefore slightly different, being more compressed in the former than the latter; on the other hand the general shape of the shell, the

width of the umbilicus, but particularly the character of the fine and regular ribs which die out towards the umbilical edge, agree so well in both forms that I do not think that the difference noted above justifies a specific separation.

Professor Waagen has so clearly indicated the characters by which *Macrocephalites macrocephalus* differs from related forms, such as *Macrocephalites tumidus* or *Macrocephalites transiens*, that nothing more can be added.

MACROCEPHALITES TRANSIENS, Waagen sp. Pl. X, fig. 2.

1871. *Stephanoceras macrocephalum* (Schl.) Waagen : Records, Geol. Surv. of India, 1871, p. 93 (pars.)

1875. *Stephanoceras transiens*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 111, Pl. XXXII., fig. 2 a, b. 3. a, b.

Measurements.

| | |
|--|---------|
| Diameter of the shell | 165 mm. |
| „ of the umbilicus | 20 „ |
| Height of the last whorl from the umbilical suture | 86 „ |
| „ „ „ from the preceding whorl | 65 „ |

The shell is discoidal, the whorls overlapping each other almost entirely, so that a very narrow umbilicus is formed. The sides of the whorls are flattened and slope very slightly from the rounded umbilical edge towards the rounded umbilical side. The thickness of the whorls being considerably less than their height, and the cross-section is therefore of the form of an ellipse with a long vertical axis.

The ornamentation consists of numerous low rounded ribs, which begin on the umbilical wall and extend to about the middle of the height, with a slight inward curve gradually becoming broader. Each of these ribs then branches into three or four, which are very regular equidistant and rounded, and pass over the siphonal side, where they attain their maximum development.

Sutural line very indistinctly seen.

Locality and stratigraphical position.—Mazâr Drik ; *Polyphemus*-limestone.

Remarks.—The chief distinguishing characters of this species are the moderately strong ribs extending over the whole of the sides from the umbilical edge to the siphonal side, and the comparatively narrow umbilicus. The specimen from Baluchistán, although considerably deformed by pressure, shows the above-mentioned features so exceedingly well, that there can be no doubt as to its identify with the form from Kutch.

Professor Waagen's figures are in this case entirely misleading, figs. 2a and 2b being found to differ materially from the original. They lead one to believe that the original is an exceedingly well preserved specimen ; this is, however, by no means the case, it being considerably damaged. If we take first fig. 2a we notice that (1) the sharp, well-defined umbilicus, as depicted, does not exist in the original, it being almost entirely filled up with matrix, so much so that there is no sharp outline, particularly on the left-hand side ; (2) the upper third of the figure is entirely restored, this portion of the original being weathered to such an extent that the first four ribs of the figure do not in reality exist ; (3) at the lower left-hand

part of the last whorl a considerable piece has been broken off in the original, the ribs being almost completely effaced. As regards the front view (2b) it must be stated (1) that the fine sharp cross-section of the last whorl is entirely wanting in the original, in fact it is wholly imaginary, and (2) that the siphonal view of the posterior part of the last whorl is equally imaginary, inasmuch as in the original a large part of the right-hand side is broken away, so that the siphonal lobe of the septum is exposed.

I regret the necessity for such strong criticism, but in support of the above statements I give here a figure of Professor Waagen's original *Stephanoceras transiens* as it really appears in order to facilitate a comparison between the restored figure and the type specimen.

MACROCEPHALITES POLYPHEMUS, Waagen. Pl. XI, fig. 1-1a.

1875. *Stephanoceras polyphemus*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 116, Pl. XXIX, fig. 2 (non fig. 1a, 1b!)

| Dimensions. | I. | II. |
|--|---------|---------|
| Diameter of the shell | 425 mm. | 255 mm. |
| „ of the umbilicus | 94 „ | 40 „ |
| Height of the last whorl from the umbilical suture | 190 „ | 140 „ |
| „ „ „ „ „ from the preceding whorl | 116 „ | 70 „ |
| Thickness of the last whorl | 125 „ | 120 „ |

The shell consists of inflated but rather low whorls which overlap each other so completely that the umbilicus becomes very narrow. The sides are rounded, and gradually slope from the umbilical edge towards the rounded siphonal side. The ornamentation consists of strong ribs which begin at the umbilical edge and divide at a short distance above it into three or four branches which are very regular in thickness, equidistant, and pass round the siphonal side, where they attain their greatest development.

Body-chamber, about $\frac{5}{8}$ of the entire whorl.

Sutural line only indistinctly seen.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is easily distinguished from the others by its low inflated whorls, and the rather coarse ribs, which subdivide close to the umbilical edge, but it is a noticeable fact that they become entirely effaced on the enormous specimens, such as No. 1. This species is rather common in Baluchistán, where it attains dimensions which according to Mr. Griesbach are even greater than those of No. 1, of which the measurements are given above.

I had some difficulty in identifying this species, as it is not quite certain what form really represents *Stephanoceras polyphemus*, Waagen. According to Professor Waagen's figure 2a and 2b the shell of *Stephanoceras polyphemus* consists of low whorls which are approximately square in cross-section. If fig. 1b may be relied upon it was not very involute, and fig. 1a distinctly shows that the umbilicus was not very narrow. Unfortunately the specimen referred to could not be found in the

collection of the Geological Survey Museum, the only specimen there preserved being that from which the sutural line, fig. 2, has been figured. But this specimen differs so entirely as regards the shape of the shell from that figured on Plate XXIX, fig. 1a, 1b, that I am at a loss to understand how these two specimens could have been referred to one and the same species. The section of the whorls is not approximately square as in the former, but is elliptical, and the overlap of the whorls is too pronounced to accord with Professor Waagen's figure. The umbilicus is therefore much narrower than is represented in fig. 1a.

As the original of fig. 1a and 1b cannot be traced, and has apparently been lost, it is impossible to say how far fig. 1a and 1b, which are drawn to half the natural scale, represent its features; we must therefore fall back on the specimen from which the sutural line has been figured if we wish to study the features of the *Stephanoceras polyphemus*, and for this purpose I give a figure of this specimen, Pl. XII, fig. 1 and 2, from which its difference from Waagen's fig. 1a and 2b will be apparent.

Under these circumstances I think I am justified in retaining the specific name "*polyphemus*" for the form from which the sutural line has been figured, and in discarding Waagen's fig. 1a and 1b altogether. Should it, however, be found again, or should new specimens be found which answer to that figure, and could it therefore be proved that the figure is really correct, that form might receive a new name. If, on the other hand, by means of the original or other specimens, it could be proved that the figure is incorrect, the above arguments would hold good. As regards ornamentation and shape of the shell the specimens from Baluchistán agree so well with the specimen from which the sutural line has been figured, that they must be considered as identical with that form. On the other hand, they are entirely different from Waagen's fig. 1a and 1b of *Stephanoceras polyphemus*.

MACROCEPHALITES SUBCOMPRESSUS, Waagen. Pl. IX., fig. 2.

1875. *Stephanoceras subcompressum*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 139, Pl. XXXIV, fig. 1a. b.

None of the specimens under examination are sufficiently well-preserved to allow of accurate measurements being taken, but it seems that this form attained only moderate dimensions, the largest specimen being probably not more than 110^{mm} in diameter. The whorls are high and laterally compressed, considerably overlapping each other; umbilicus tolerably wide. The sides are covered with very equal, sharp ribs which rise at the umbilical edge. They are slightly bent forward, and at about the middle of the height of the whorl they generally bifurcate; sometimes a secondary rib is intercalated between two primary ones, approximately taking its origin at their point of bifurcation. All the ribs are of equal strength, more prominent on the siphonal portion than on the sides, and follow each other at equal intervals. On the siphonal side the ribs are still more bent forward than on the sides. Neither body-chamber nor sutural line can be observed.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—According to Professor Waagen this species is easily distinguished

from others by its larger umbilicus, and the curve of the stronger ribs on the siphonal side.

Unfortunately the Baluchistán specimens are too much distorted to allow of the features of the umbilicus being studied, but so far as can be seen, this form certainly differs by a wider umbilicus from the other species here described. A much better distinguishing feature, however, is the character of the ribs, which are well marked and bend slightly forward. I must however state, that owing to the bad state of preservation of the Baluchistán specimens, it would have been impossible to identify them with this species, had I been unable to compare them with Professor Waagen's original. This specimen, which represents a somewhat larger shell than any of those under examination, seems to differ by somewhat stronger ribs and a slightly flattened siphonal side; but considering that the flattening of the siphonal side does not take place until the beginning of the last whorl, I consider this a character which can only be noticed in specimens which have attained a certain size. On the other hand, it can be seen that the ribs become stronger with increasing size, and that the smaller specimens from Baluchistán must necessarily have finer ribs. It must also be mentioned that these specimens prove that the strength of the ribs is seriously influenced by the weathering, and that originally the ribs were stronger than they are now.

MACROCEPHALITES LAMELLOSUS, Sowerby, sp. Pl. VII, fig. 3-3a.

1875. *Stephanoceras lamellosum*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 122, Pl. XXXIII, fig. 1a, b.

| Dimensions. | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---------|
| Diameter of the shell | . | . | . | . | . | . | . | . | 110 mm. |
| " of the umbilicus | . | . | . | . | . | . | . | . | 20 " |
| Height of the last whorl from the umbilical suture | . | . | . | . | . | . | . | . | 50 " |
| " " " from the preceding whorl | . | . | . | . | . | . | . | . | 32 " |
| Thickness of the last whorl | . | . | . | . | . | . | . | . | 50(?) " |

The shell consists of slightly inflated and flattened whorls which almost completely envelope each other, thus leaving a narrow umbilicus. The whorls are rather low and increase in size but slowly; the sides are almost flat and slope only slightly near the siphonal side. The cross-section is a flattened ellipse. The sides are covered with very strong, sharp and high ribs which begin at the umbilical edge and run in a straight line towards the siphonal side; at a point somewhat below the middle of the height they divide into two or three branches of nearly the same strength as the original stem; these bend imperceptibly forward and pass at equal intervals over the siphonal side.

One specimen shows part of the inner whorls, which are covered with rather fine ribs distinctly inclined forward on the siphonal side.

Sutural line very indistinct.

Body-chamber not preserved.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—*Macrocephalites lamellosus* is easily recognised by the character of the ribs; while all the former species, even *Macrocephalites polyphemus*, possessed rather fine rounded ribs, this species exhibits thick and sharp ribs, which are very prominent on the siphonal side.

Professor Waagen compares this form with *Macrocephalites grantanum*, Oppel, a form which is readily distinguished by its still coarser and sharper ribs.

The original figure of this species has also been considerably restored, particularly fig. 1b, in which the right-hand upper portion has been added. As regards fig. 1a, the ribs are by no means so well preserved in the original as might appear from the figure. I further think that their strength has been somewhat exaggerated in the drawing, which represents them as being much thicker than the interstices, while in the original the ribs are much thinner, ribs and interstices being of nearly the same strength.

MACROCEPHALITES GRANTANUM, Oppel, sp. Pl. IX, fig. 3-3a.

1875. *Stephanoceras grantanum*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 123, Pl. XXXVI, fig. 6a, b.

Among the specimens from Baluchistán several belong to a form with very low depressed whorls of which the height is about double the breadth, and a very narrow, apparently deep umbilicus. They are covered with very regular, sharp ribs which begin near the umbilical edge, and after having divided generally into two, sometimes three, branches, pass straight over the siphonal side. Owing to the bad state of preservation no further details could be observed.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—The specimens which have been examined are with one exception all deformed by pressure. The only one in which the shape is preserved, is however so much weathered, that with the exception of a small portion of the siphonal side, not much can be seen. I have, however, compared these specimens with Professor Waagen's original, and I am convinced that they agree so well with that form, that notwithstanding their imperfect state of preservation, they can be identified with *Stephanoceras grantanum*, Oppel, sp. Professor Waagen has so clearly stated the difference of this species from other forms more or less related to it, that it is unnecessary for me to repeat them here.

MACROCEPHALITES OPIS, Sowerby, sp. Pl. VII., fig. 2-2 a.

1875. *Stephanoceras opis*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 140, Pl. XXXVI, fig. 1a, b, 2, 3.

A considerably deformed specimen of *Macrocephalites* can with all probability be referred to the above species. The shell consists of high whorls, laterally much compressed, which overlap each other to such an extent that only a very narrow

umbilicus remains. The ribs, which are very fine and sharp, begin at the umbilical edge, and divide into two or three branches at about the middle of the height. These secondary ribs are of equal strength, are equidistant and pass over the siphonal side.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is rather rare at Mazár Drik, and I doubt if I should ever have been able to identify it with the above species, had I not had Professor Waagen's original for comparison. This species shows, as Professor Waagen correctly remarks, a great resemblance to *Macrocephalites transiens*, Waagen, and it is rather difficult to distinguish even well-preserved specimens of the two forms from each other. According to Professor Waagen the chief distinguishing features of *Macrocephalites opis* consist in the narrow umbilicus and the smaller curve of the ribs towards the front on the siphonal side. It is quite clear that such delicate and minute distinctions can hardly be noticed on a specimen that has been in any way deformed by pressure. If I were solely to rely upon these two distinctive features, I should have been unable to identify the specimen described above, the ribs having been unquestionably squeezed out of position; it is, however, quite certain that the umbilicus is very narrow—narrower in fact than it would be in a specimen of *Macrocephalites transiens*, Waagen, of the same size.

On comparing it with the original of Waagen's fig. 2, I found that the character of the ribs agrees so well with that form that they must be considered as identical.

It must, however, be noticed that the character of the ribs of this species is rather variable. One of Professor Waagen's originals, which is of much smaller dimensions than his fig. 2, but larger than fig. 3, exhibits much more inflated whorls and stronger and less regular ribs than fig. 2. It must further be mentioned that his fig. 2 has been considerably restored in the right-hand upper portion, and I am of the opinion that the cross-section of the last whorl is not quite in accordance with the original which is a little more compressed at the umbilical edge than is shown in the figure.

2. Sub-family: *PERISPHINCTINÆ*, Steinm.

Genus: *PERISPHINCTES*, Waagen.

PERISPHINCTES BALINENSIS, Waagen (non Neumayr). Pl. XIII, fig. 1.

1875. *Perisphinctes balinensis*, Waagen, Palæontologia Indica, Jurassic Fauna of Kutch, Vol. I, p. 163, Pl. XLV, fig. 2a, b.

| Dimensions. | | | | | | I. | II. |
|--|---|---|---|---|---|----|-----|
| Diameter of the shell | . | . | . | . | . | 67 | 71 |
| „ of the umbilicus | . | . | . | . | . | 29 | 29 |
| Height of the last whorl from the umbilical suture | . | . | . | . | . | 21 | 23 |
| „ „ „ from the preceding whorl | . | . | . | . | . | 17 | 20 |
| Thickness of the last whorl | . | . | . | . | . | 16 | 18 |

The shell consists of more than six flat, low whorls, which very gradually increase in height, and overlap each other only to a small extent. The umbilicus is therefore wide and the inner whorls are well exposed. The umbilical wall is very

low and rounded. The flat sides gradually slope towards the rounded siphonal side. There are about four not very distinct contractions to one volution. The whorls are covered with straight rounded ribs, which begin at the umbilical edge and extend to about half the height of the whorl, where they split up into three finer branches, which pass in a straight line round the siphonal side. Neither body-chamber nor sutural lines to be seen.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is fairly common at Mazár Drik, although none of the specimens are particularly well preserved. However, as I could compare them with Professor Waagen's original of *Perisphinctes balinensis*, I was enabled to establish their identity with that form, which is characterized by its very evolute shell and the straight ribs which are fairly strong near the umbilical edge, but gradually become thinner before they branch into the regular thin ribs, which pass round the siphonal side. I have therefore no doubt that the Baluchistán specimens represent the same form as those from Kutch, but I cannot quite agree with Professor Waagen, who is of opinion that the latter are identical with Neumayr's *Perisphinctes balinensis*. It seems to me that *Perisphinctes balinensis*, Waagen, differs from *Perisphinctes balinensis*, Neumayr, by a much more evolute shell and consequently a wider umbilicus, which allows of the exposure of a larger number of whorls, a feature which will be at once noticed when comparing the figures of the two authors. I am rather inclined to think that *Perisphinctes balinensis*, Waagen, bears a much closer relationship to *Perisphinctes furcula*, Neumayr, than to the *P. balinensis* of that author. In both forms we have the same evolute shell, and, what is more, the character of the ribs is the same, inasmuch as the primary ribs split up into three finer branches. It must, however, be noted that the smaller specimens from Baluchistán show that on the earlier whorls the ribs frequently divide into two branches, a character which was probably unnoticed by Neumayr owing to the fact that the point where the primary ribs divide is hidden in the inner whorls and only two specimens were available for examination.

Although I am, therefore, of the opinion that Professor Waagen's *Perisphinctes balinensis* would have been better identified with Neumayr's *Perisphinctes furcula*, I retain Professor Waagen's determination, for I think that this question can only be settled by actual comparison of the type specimens. On the other hand, it must be understood that, whatever the specific name of *Perisphinctes balinensis*, Waagen, may be, that form is identical with the Baluchistán specimens which have been here described.

PERISPHINGTES BALUCHISTANENSIS SPEC. NOV. Pl. XIII, fig. 2-2a, fig. 3.

| Dimensions. | I. | II. |
|--|----|-----|
| Diameter of the shell | 82 | 71 |
| " of the umbilicus | 35 | 29 |
| Height of the last whorl from the umbilical suture | 25 | 24 |
| " " " from the preceding whorl | 20 | ? |
| Thickness of the last whorl | 20 | 91 |

The discoid shell consists of low rounded whorls which increase very slowly in height and scarcely overlap each other. The umbilicus is therefore fairly wide and rather deep. The sides are rounded and drop very suddenly towards the umbilicus and the siphonal side, which is slightly flattened. Cross-section elliptical.

The sides are covered with very regular strong and sharp ribs, which rise at the umbilical suture, and run with a slight curve towards the aperture, till at about $\frac{2}{3}$ of the height of the whorl they split into two or three thinner branches which run over the siphonal side, exhibiting a slight backward curve in the centre, with a few rather deep contractions.

Sutural line not seen.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is easily distinguished from all the others by its evolute shell consisting of low rounded whorls. Although I have no specimens attaining the size of those described by Professor Waagen, those I have examined agree so well with his fig. 2 that they must be considered as identical with that species.

Professor Waagen mentions that the lobes of the specimens from Kutch do not quite agree in every particular with Gemmellaro's drawing: as that author lays special stress on the sutural line of *Perisphinctes recuperoi*, by which it is distinguished from *Perisphinctes euryptychus*, Neumayr, it may perhaps be probable that the Kutch specimens represent a form different from Gemmellaro's species. However, whether this view is correct or not, the specimens from Baluchistán certainly represent the same species as those from Kutch.

PERISPINCTES ABERRANS, Waagen. Plate XIII, fig. 5.

1875. *Perisphinctes aberrans*, Waagen, *Palæontologia Indica*, Jurassic Fauna of Kutch, Vol. I, p. 175, Pl. XV, fig. 1a, b, c, 2a, b.

Dimensions.

| | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|-------|---------|
| Diameter of the shell | . | . | . | . | . | . | . | . | 222 | 190 mm. |
| " of the umbilicus | . | . | . | . | . | . | . | . | 97(?) | 70 " |
| Height of the last whorl from the umbilical suture | . | . | . | . | . | . | . | . | 77 | 63 " |
| " " " from the preceding whorl | . | . | . | . | . | . | . | . | ? | ? |
| Thickness of the last whorl | . | . | . | . | . | . | . | . | ? | ? |

The shell consists of low whorls, laterally compressed, which very gradually increase in size and by overlapping each other to a little less than half their height produce a wide umbilicus, exposing no less than seven whorls. The umbilical wall is rather high and the umbilicus therefore tolerably deep; the umbilical edge is rounded and the flat sides slope very gradually towards the rounded siphonal side. The ribs which begin on the umbilical wall are rather strong, considerably inclined forwards, and branch into somewhat thinner ribs which pass round the siphonal side. On the inner whorls the ribs are very well marked, but with increasing size they become flatter and more indistinct, till they entirely disappear on large specimens similar to that figured. So far as could be ascertained, the specimens under examination exhibit no contractions.

No sutural line can be seen, but probably part of the body-chamber is preserved.

Locality and stratigraphical position.—Mazár Drik; *Polyphemus*-limestone.

Remarks.—This species is characterized by its evolute shell having very low compressed whorls gradually increasing in height, a wide and tolerably deep umbilicus and strong ribs, which on the siphonal side are divided into two or three finer branches, but almost entirely disappear in full-grown specimens.

The specimens from Baluchistán agree in this respect very well with the original of fig. 1 of Professor Waagen's *Perisphinctes aberrans*, but they differ from it by their lateral ribs being somewhat finer and apparently more numerous. On the other hand, the ribs on the siphonal side are much better marked on the Baluchistán specimens than on that of about the same size from Kutch. These are unquestionably differences which must be noted, but I do not think them of sufficient importance to justify the creation of a new species. Professor Waagen's figures have been considerably restored, particularly fig. 1b, and the ribs on the posterior part of the last whorl crossing the siphonal side are wholly imaginary. The original is badly damaged at this particular part, being so much worn away on either side that only a middle piece of some 18 mm. in thickness remains, and this does not exhibit the slightest trace of transverse ribs. In the original the whorls are also much more compressed than is shown in the figure.

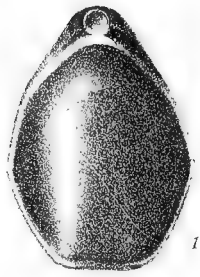
PLATE I.

| | | | |
|---------|---------------------------------|------------------------------------|--------------|
| Fig. 1. | TEREBRATULA VENTRICOSA, Zieten. | Polyphemus-limestone, Mazár Drik. | Dorsal view. |
| „ 1a. | „ „ „ | „ „ „ | Side view. |
| „ 1b. | „ „ „ | „ „ „ | Front view. |
| Fig. 2. | TEREBRATULA VENTRICOSA, Zieten. | Polyphemus-limestone, Mazár Drik. | Dorsal view. |
| „ 2a. | „ „ „ | „ „ „ | Side view. |
| Fig. 3. | TEREBRATULA VENTRICOSA, Zieten. | Polyphemus-limestone, Sembar Pass. | Dorsal view. |
| „ 3a. | „ „ „ | „ „ „ | Side view. |
| „ 3b. | „ „ „ | „ „ „ | Front view. |
| Fig. 4. | RHYNCHONELLA PLICATELLA, Sow. | Polyphemus-limestone, Sembar pass. | Dorsal view. |
| „ 4a. | „ „ „ | „ „ „ | Side view. |
| „ 4b. | „ „ „ | „ „ „ | Front view. |
| Fig. 5. | RHYNCHONELLA PLICATELLA, Sow. | Polyphemus-limestone, Mazár Drik. | Dorsal view. |
| „ 5a. | „ „ „ | „ „ „ | Side view. |
| „ 5b. | „ „ „ | „ „ „ | Front view. |
| Fig. 6. | LIMA (PLAGIOSTOMA?) sp. | Polyphemus-limestone, Mazár Drik. | |
| Fig. 7. | PHOLADOMYA SP. | Polyphemus-limestone, Mazár Drik. | |

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Pl. I.



1



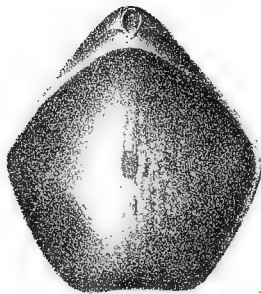
1, a.



1, b.



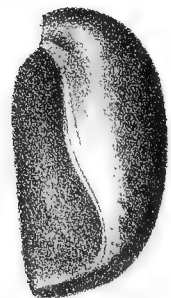
2, a.



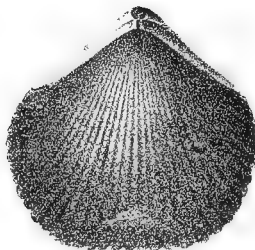
3.



3, b.



3, a.



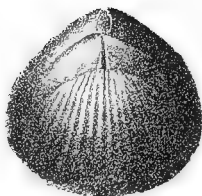
4



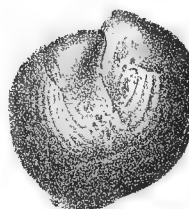
4, b.



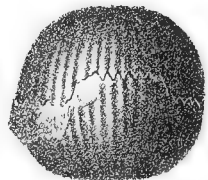
4, a.



5



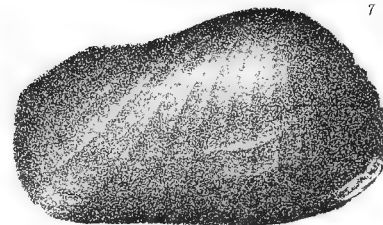
5, a.



5, b.



6



7

PLATE II.

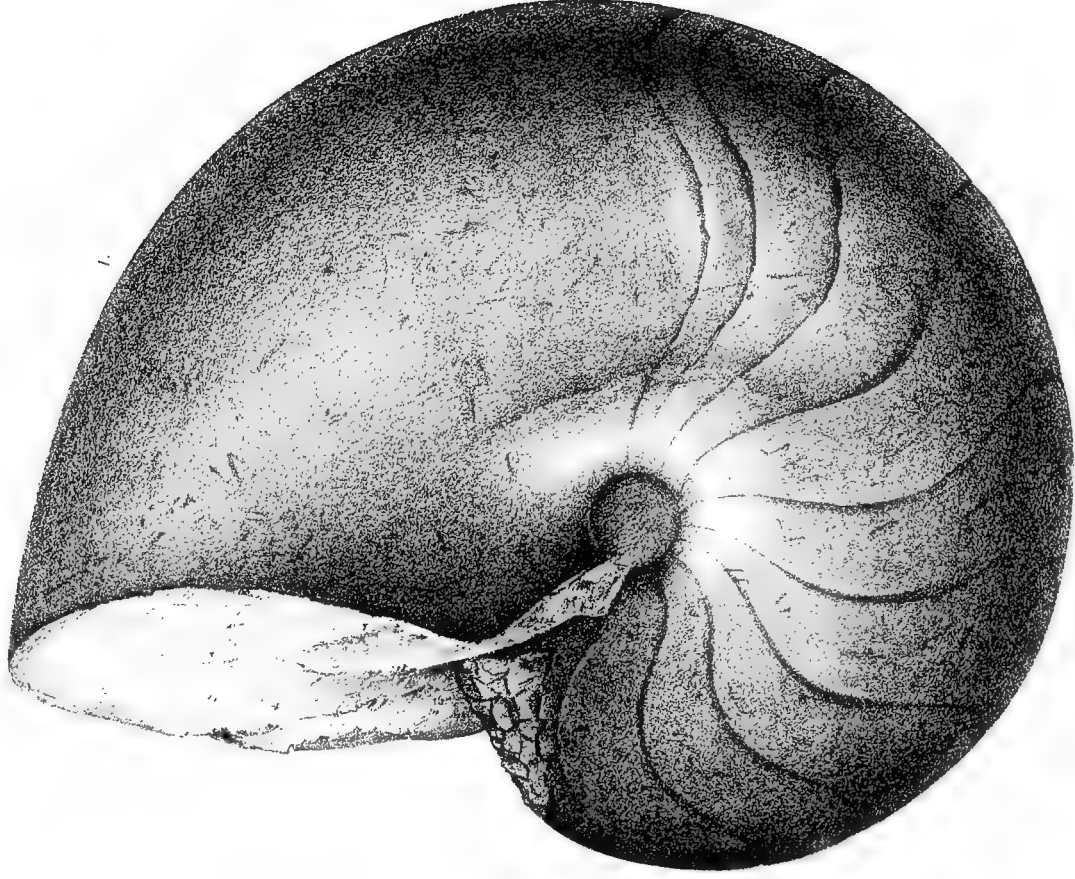
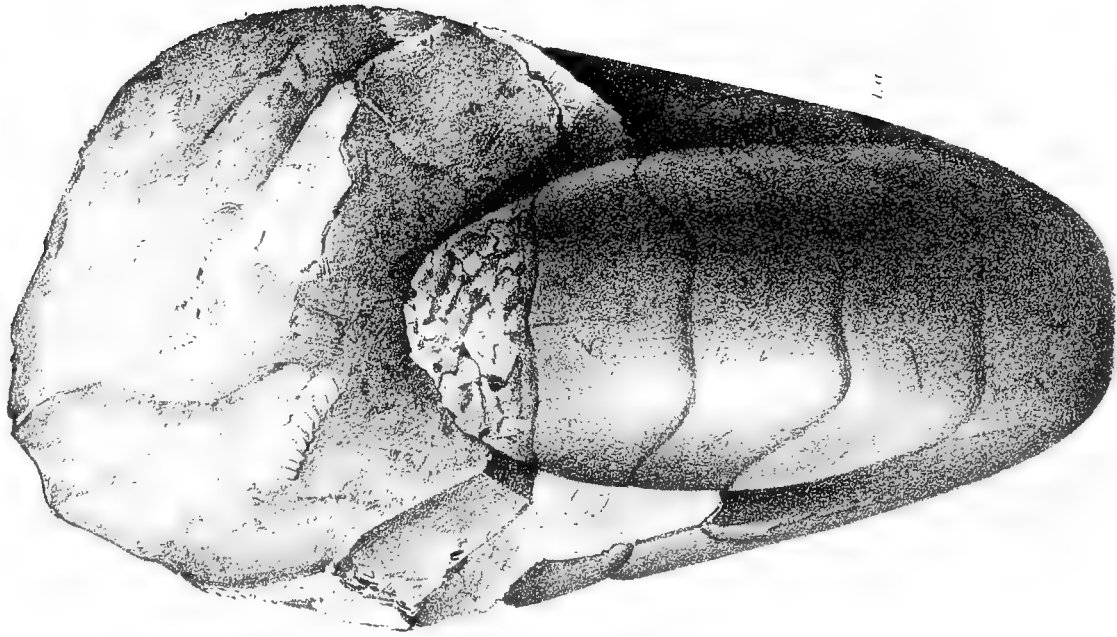
Fig. 1. NAUTILUS WANDAENSIS, Waagen. Polyphemus-limestone, Mazár Drik. Side view.
„ la. „ „ „ „ „ „ „ Front view.

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PL. II.



Kal. Dhon Chandra [6] & [11].

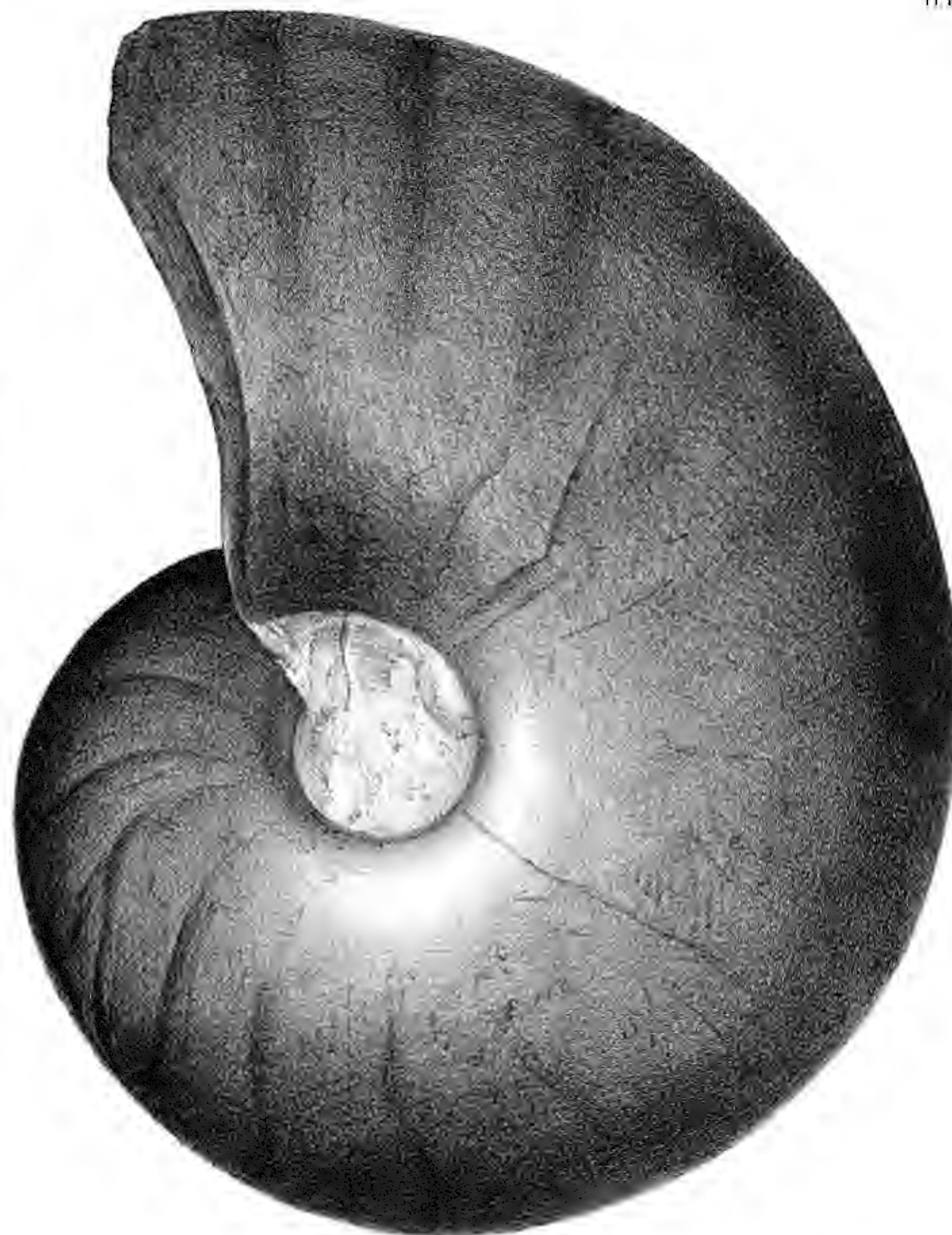
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PLATE III.

Fig. i. NAUTILUS INTUMESCENS, Waagen. Polyphemus-limestone, Mazár Drik. Side view.
„ la. „ „ „ „ „ „ „ „ Front view.



l. d.



l.

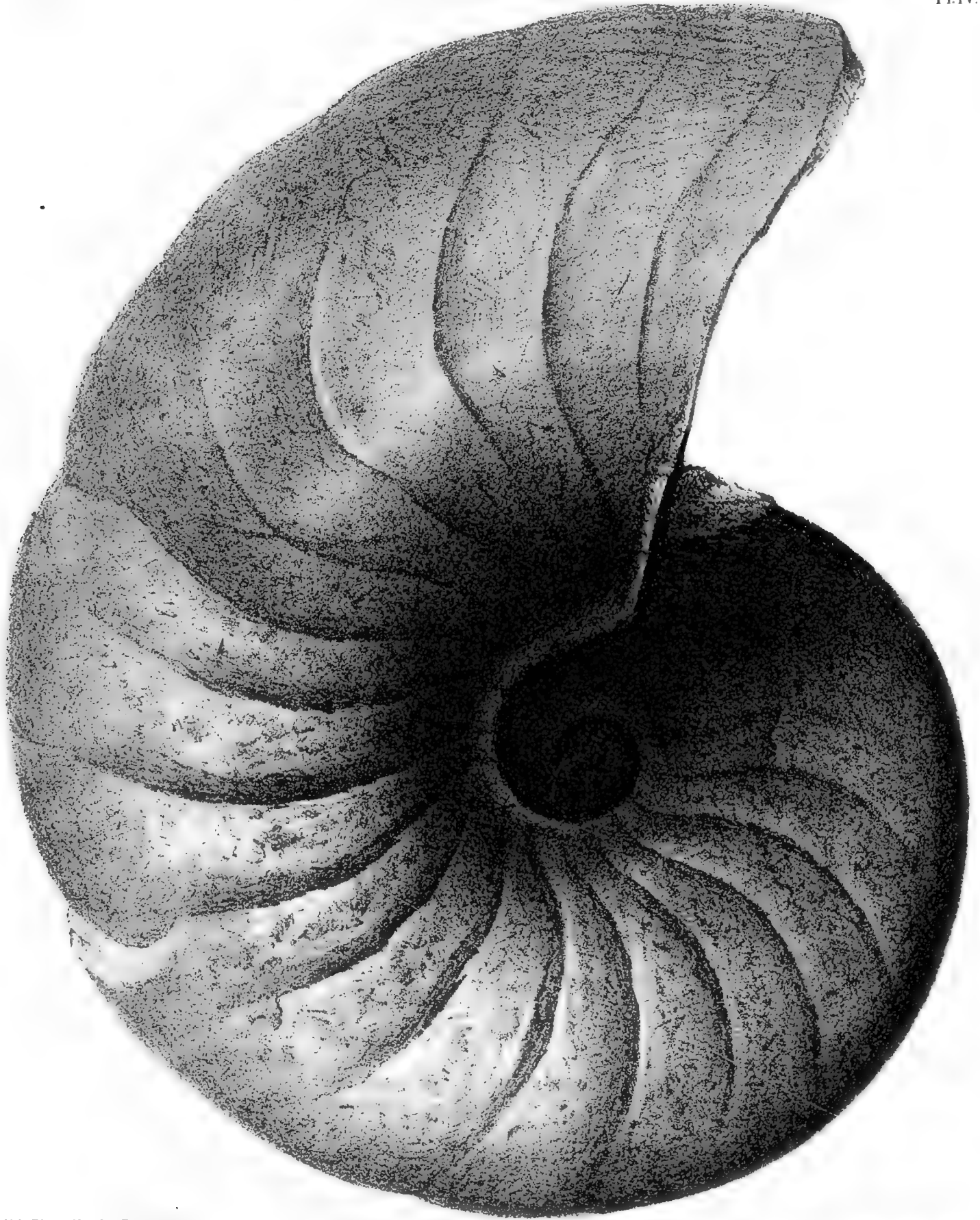
PLATE IV.

NAUTILUS GIGANTEUS, d'Orbigny. Polyphemus-limestone, Mazár Drik. Side view.

JURASSIC FOSSILS OF BALUCHISTÁN.

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PL. IV.



Kali Dhan Chandra De &

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PLATE V.

NAUTILUS GIGANTEUS, d'Orbigny. Polyphemus-limestone, Mazár Drik. Front view.



Fig. 1. *Trilobites*.

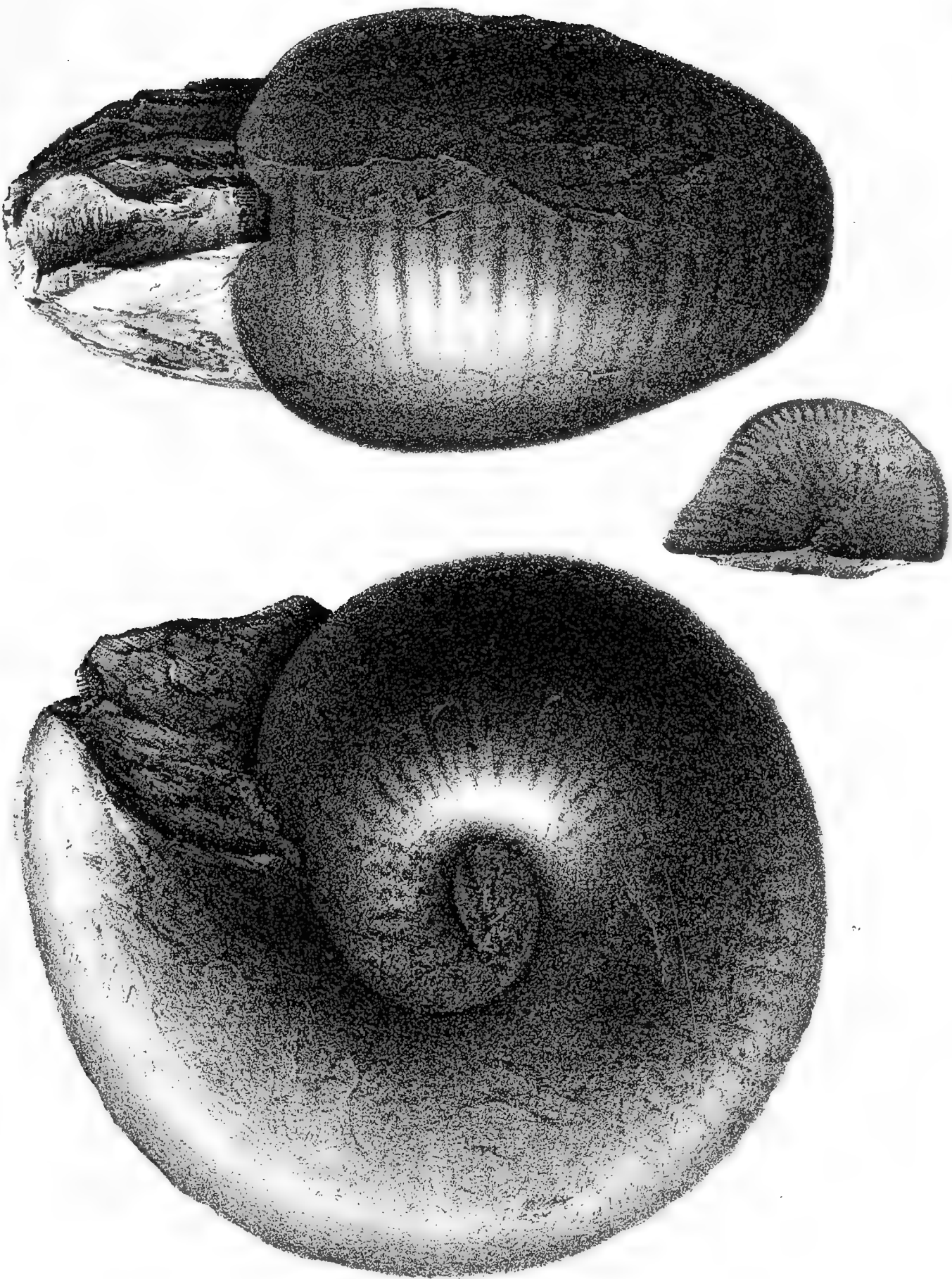
Fig. 2. *Trilobites*.

PLATE VI.

Fig. 1. *HAEPOCERAS*, sp. Polyphemus-limestone, Mazár Drik. Side view.

Fig. 2. *SPHÆROCERAS BULLATUM*, d'Orbigny sp. Polyphemus-limestone, Mazár Drik. Side view.

Fig. 2a. *SPHÆROCERAS BULLATUM*, d'Orbigny sp. Polyphemus-limestone, Mazár Drik. Front view.



Fish Dhan Chander, 1914, p. 110

Fig. 10. a. b. c. d. e. f. g. h. i. j. k. l. m. n. o. p. q. r. s. t. u. v. w. x. y. z.

PLATE VII.

Fig. 1. *MACROCEPHALITES MACROCEPHALUS*, Schloth. sp. Polyphemus-limestone, Mazár Drik. Side view.

Fig. 1a. *MACROCEPHALITES MACROCEPHALUS*, Schloth. sp. Polyphemus-limestone, Mazár Drik. Front view.

Fig. 2. *MACROCEPHALITES OPIS*, Sow. sp. Polyphemus-limestone, Mazár Drik. Side view.

„ 2a. „ „ „ „ „ „ „ „ Front view.

Fig. 3. *MACROCEPHALITES LAMELLOSUS*, Waagen. Polyphemus-limestone, Mazár Drik. Side view.

Fig. 3a. *MACROCEPHALITES LAMELLOSUS*, Waagen. Polyphemus-limestone, Mazár Drik. Front view.

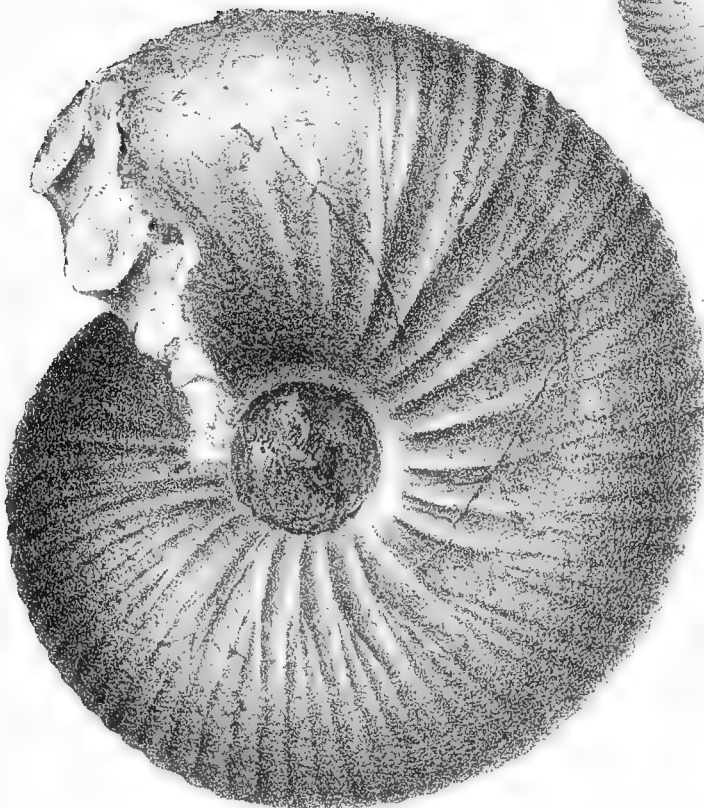
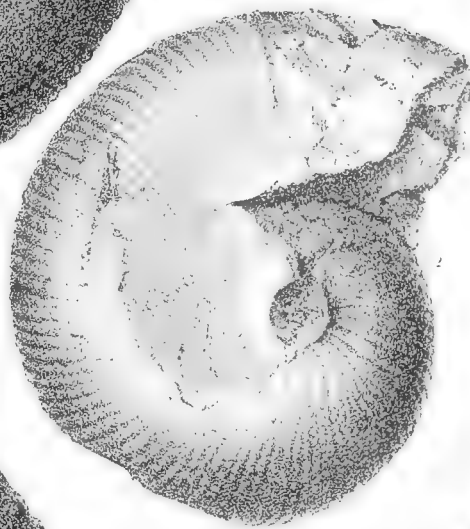
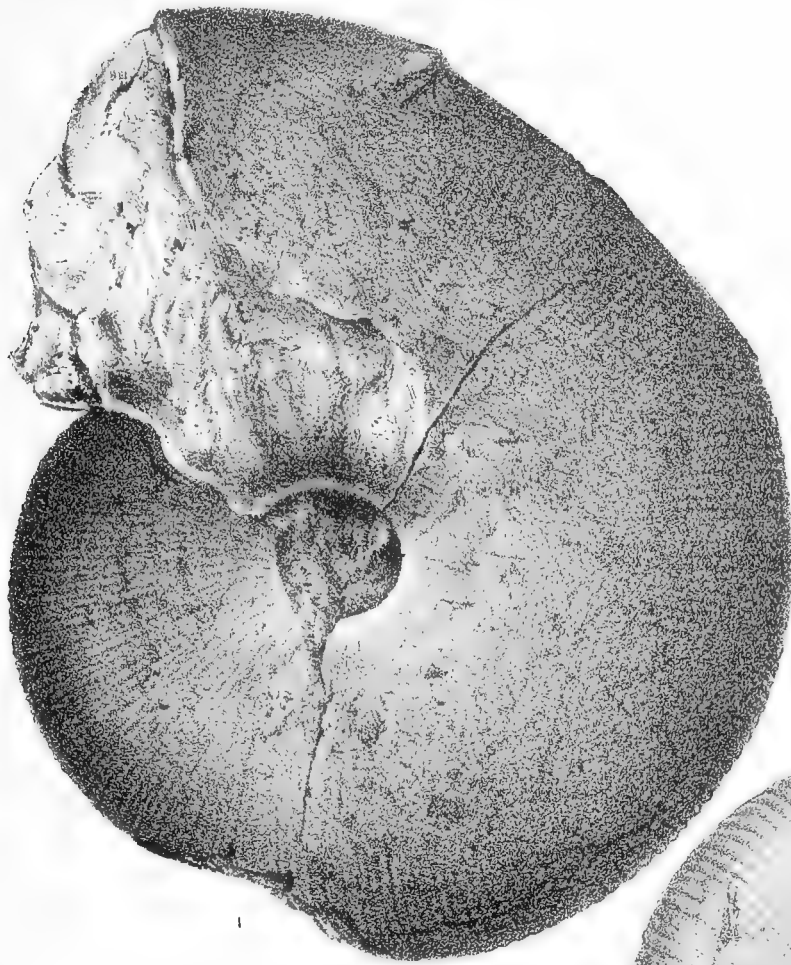


PLATE VIII.

MACROCEPHALITES MACROCEPHALUS, Schloth. sp. Polyphemus-limestone, Mazár Drik. Side view.

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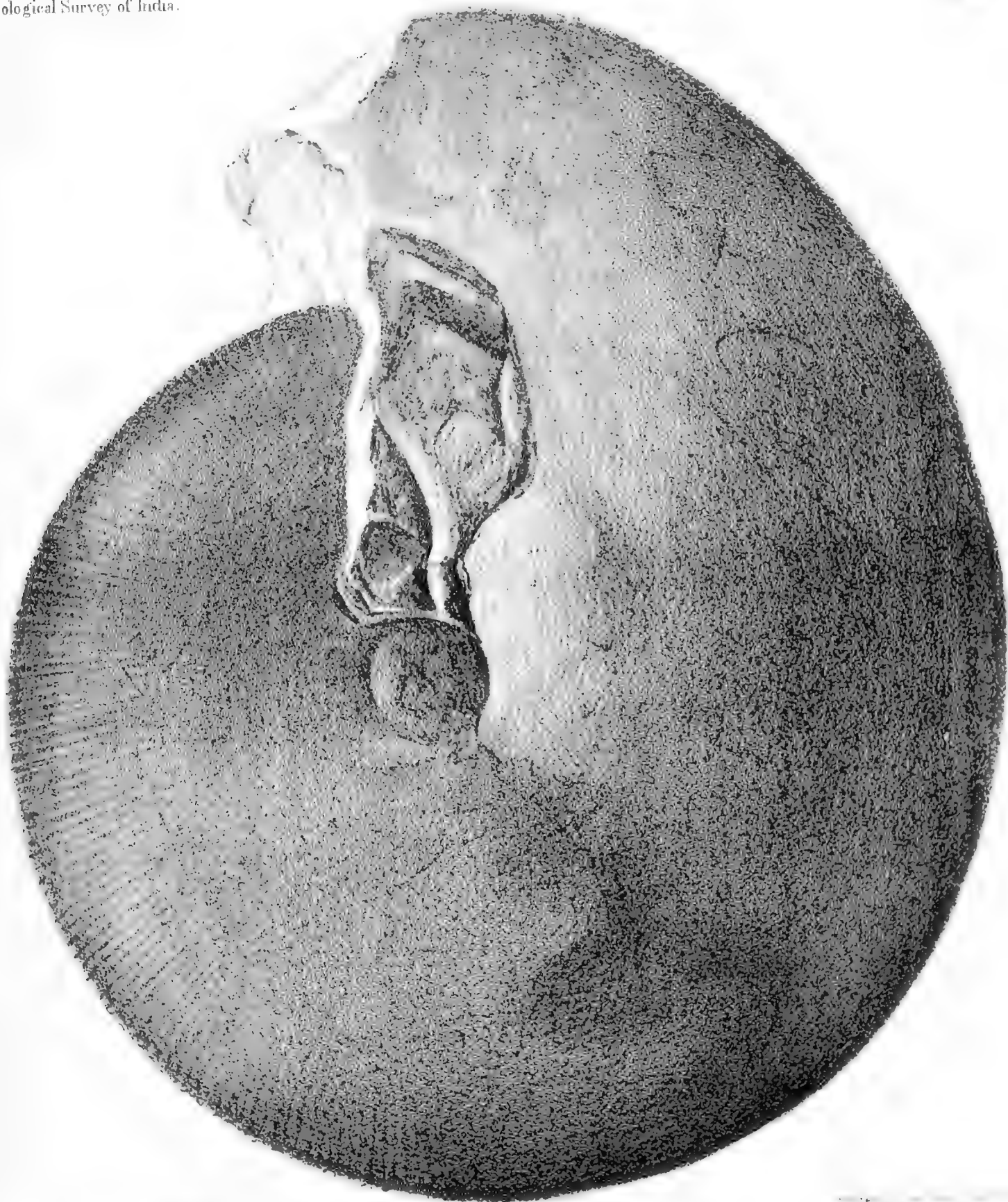


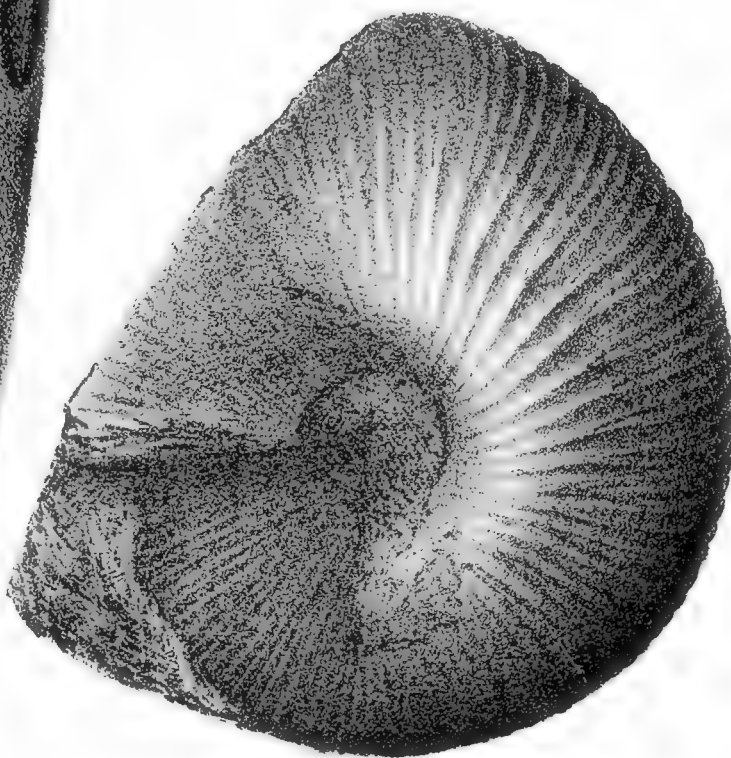
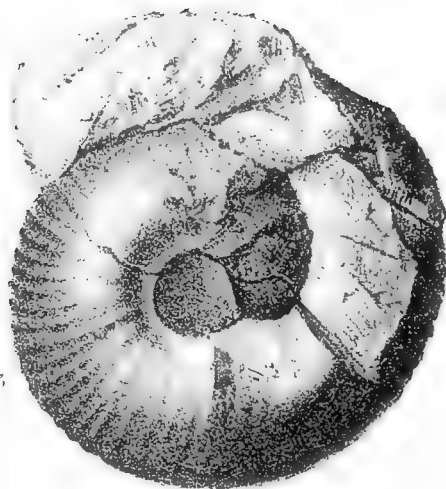
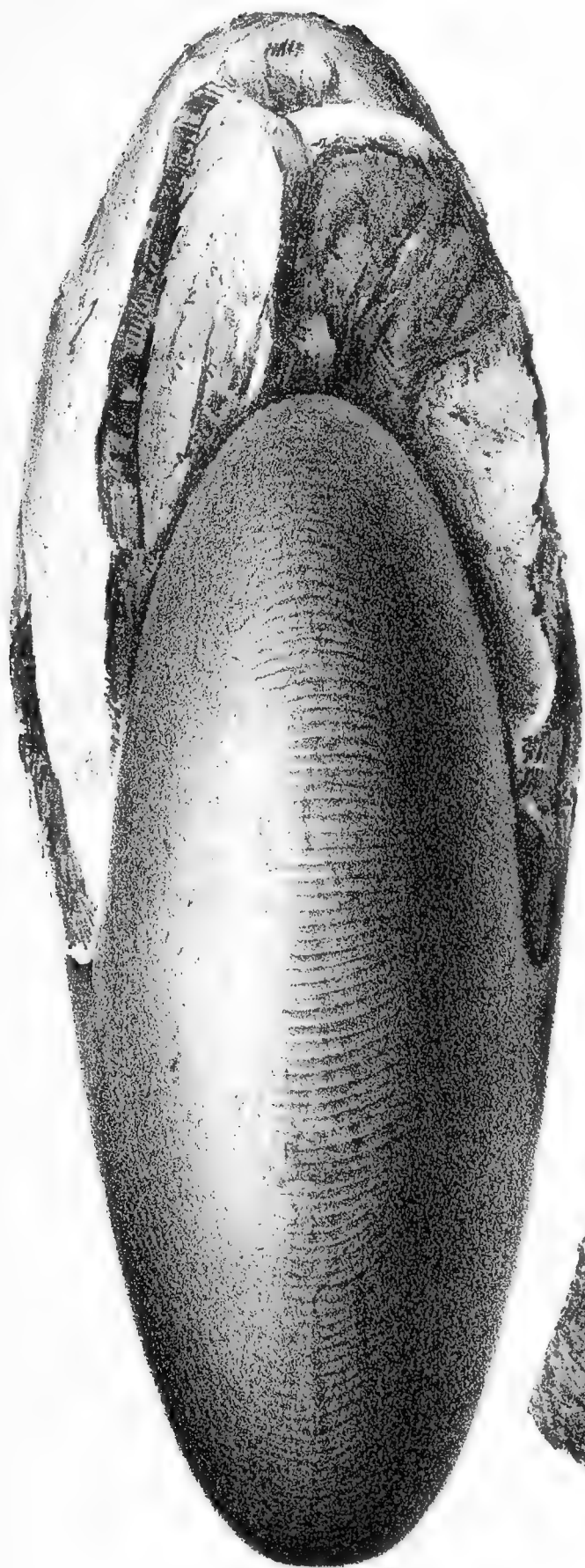
PLATE IX.

- Fig. 1. **MACROCEPHALITES MACROCEPHALUS**, Schloth. sp. Polyphemus-limestone, Mazár Drik. Front view.
- Fig. 2. **MACROCEPHALITES SUBCOMPRESSUS**, Waagen. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 3. **MACROCEPHALITES GRANTANUM**, Oppel. sp. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 3a. **MACROCEPHALITES GRANTANUM**, Oppel. sp. Polyphemus-limestone, Mazár Drik. Front view.

JURASSIC FOSSILS OF BALUCHISTÁN.

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PL IX



2

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PLATE X.

- Fig. 1. **MACROCEPHALITES TRANSIENS**, Waagen. Dhosa-Oolite, Kutch, Type specimen of Waagen's *Mac. transiens*, Jurassic Fauna of Kutch, Vol. I, pl. XXXII, fig. 2a. Side view.
- Fig. 2. **MACROCEPHALITES TRANSIENS**, Waagen. Polyphemus-limestone, Mazár Drik. Side view.

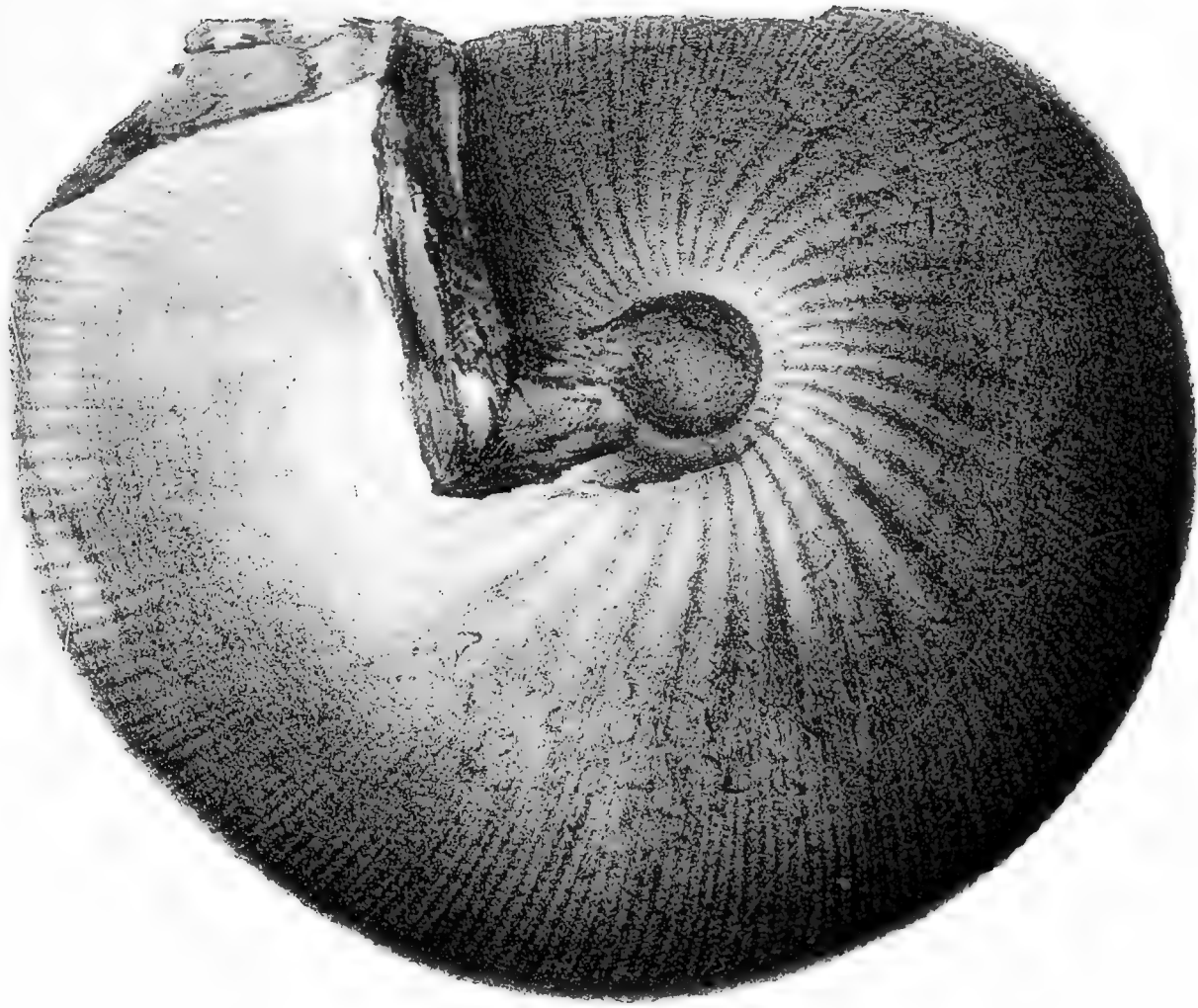
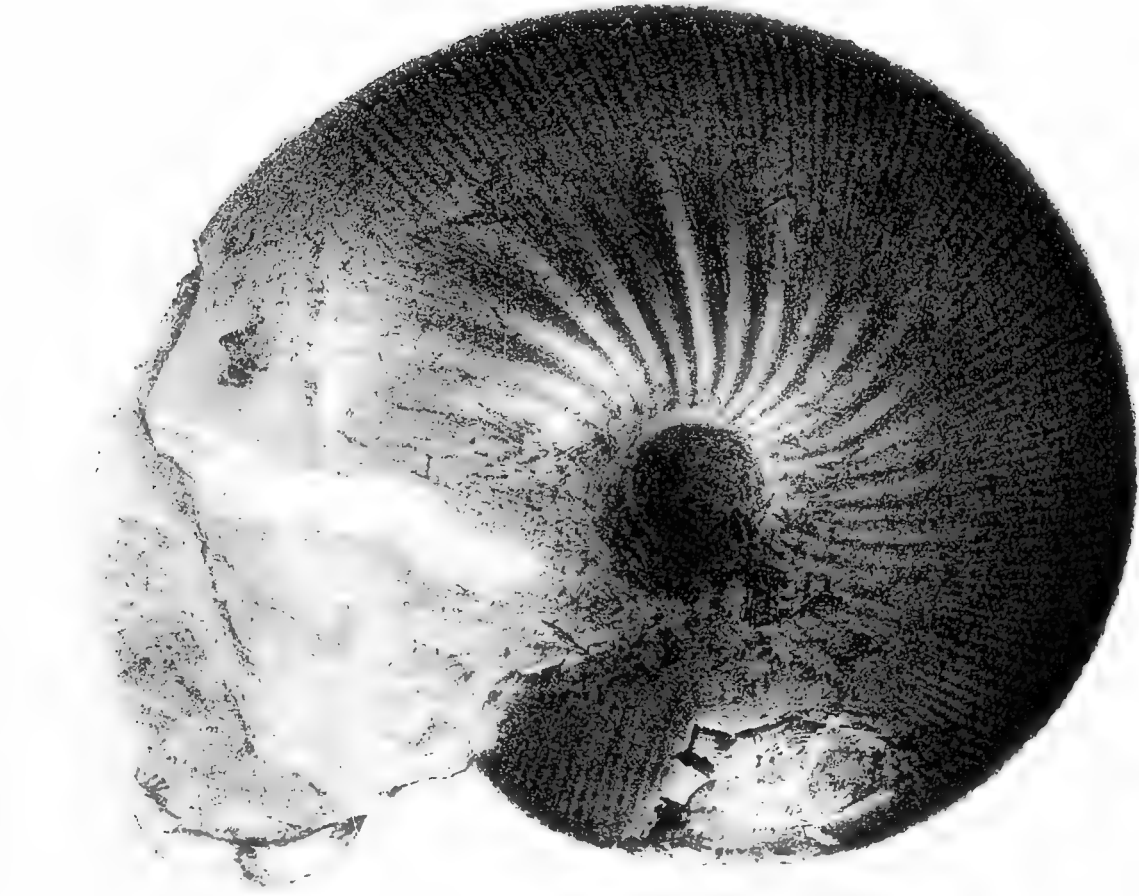
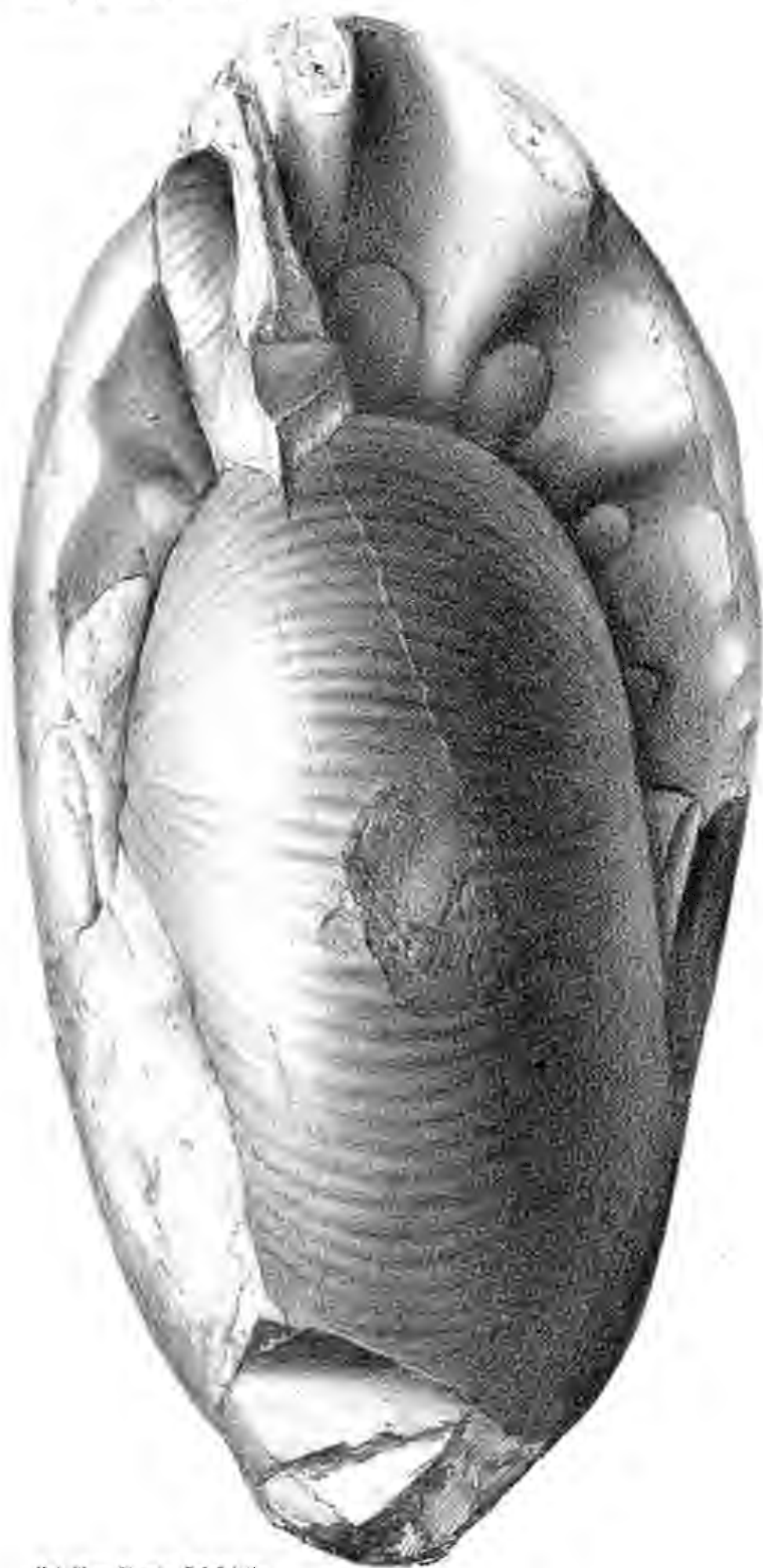


PLATE XI.

Fig. 1. MACROCEPHALITES POLYPHEMUS, Waagen. Polyphemus-limestone, Mazár Drik. Side view.

Fig. 1a. MACROCEPHALITES POLYPHEMUS, Waagen. Polyphemus-limestone, Mazár Drik. Front view.

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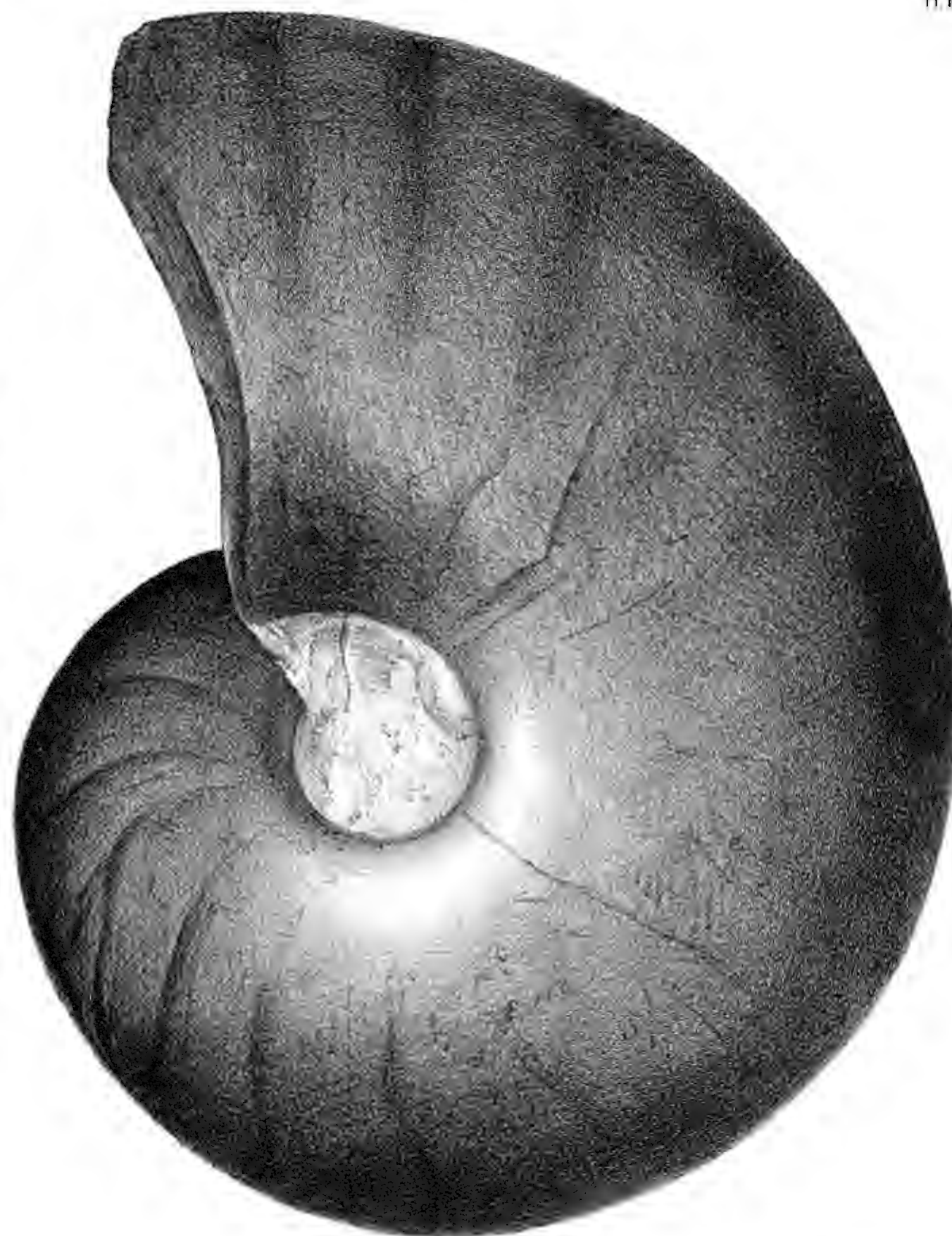


PLATE XII.

- Fig. 1. *MACROCEPHALITES POLYPHEMUS*, Waagen. Dhosa-Oolite, Kutch. Front view.
Fig. 2. *MACROCEPHALITES POLYPHEMUS*, Waagen. Dhosa-Oolite, Kutch. Side view.



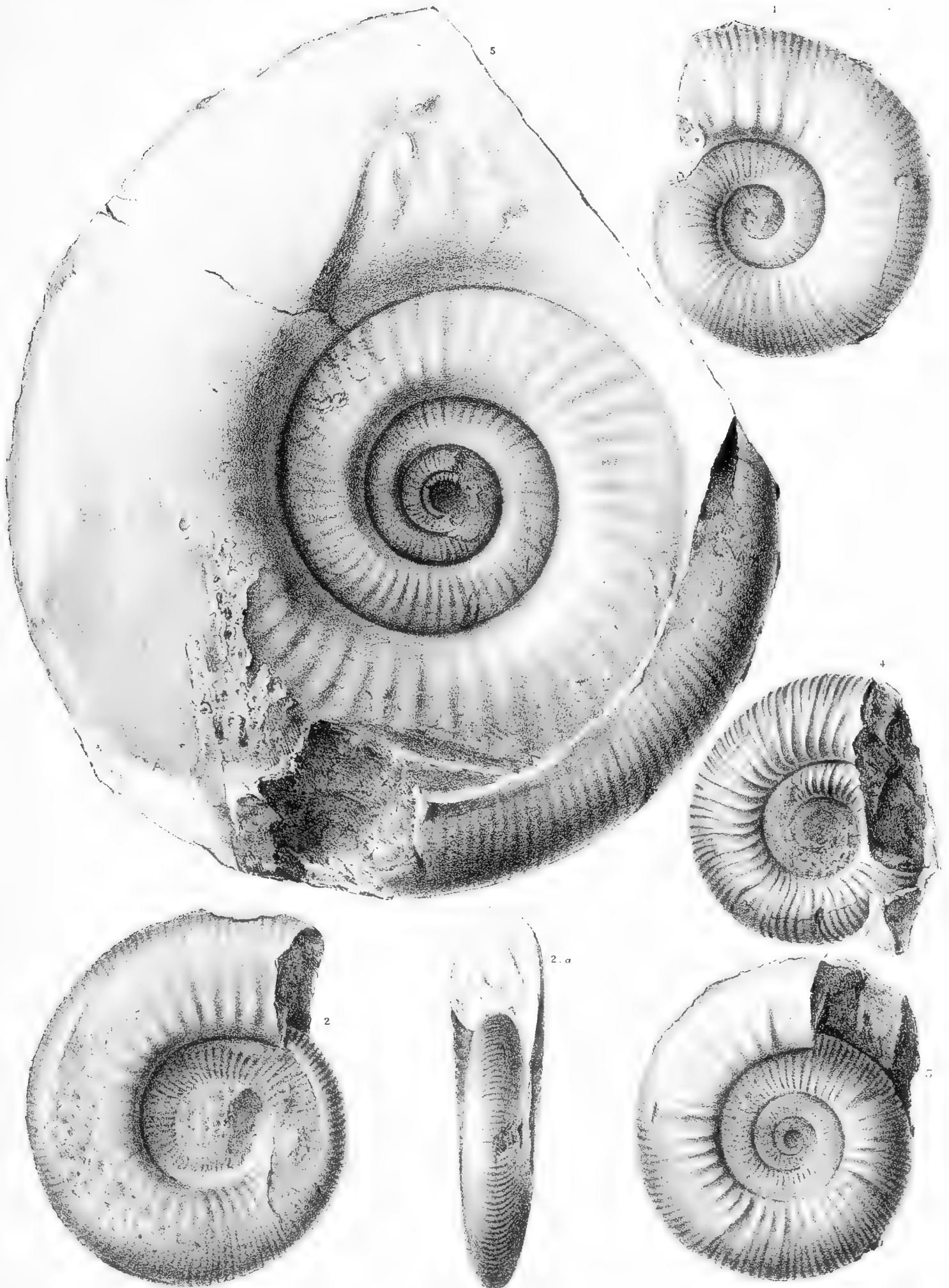
l. d.



l.

PLATE XIII.

- Fig. 1. *PERISPHINCTES BALINENSIS*, Waagen. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 2. *PERISPHINCTES BALUCHISTANENSIS*, spec. nov. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 2a. *PERISPHINCTES BALUCHISTANENSIS*, spec. nov. Polyphemus-limestone, Mazár Drik. Front view.
- Fig. 3. *PERISPHINCTES BALUCHISTANENSIS*, spec. nov. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 4. *PERISPHINCTES RECUPEROI*, Gemmellaro. Polyphemus-limestone, Mazár Drik. Side view.
- Fig. 5. *PERISPHINCTES ABERRANS*, Waagen. Polyphemus-limestone, Mazár Drik. Side view.



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FAUNA OF BALUCHISTAN.

Vol. I, Part 2.

THE FAUNA OF THE (NEOCOMIAN) BELEMNITE BEDS.

INTRODUCTION.

It may be safely presumed that the few species described in the following pages do not represent the complete fauna of the neocomian in Baluchistán, and it must also be admitted that this fauna is really poor in number of species. The collection which I examined consists almost exclusively of belemnites, but they appear in countless numbers, and the strata in which they occur have accordingly received the name of the belemnite shales. I would have refrained from describing so small a number of species, and I should have considered it better to await the collection of more material, but it appeared advisable to arrive at some definite knowledge of the fauna of the mesozoic rocks in Baluchistán.

It was of course a fact of considerable interest that beds of neocomian age should be found between the jurassic Polyphemus limestone and those strata which represent the top of the cretaceous formation, while apparently the whole of the middle and the greater part of the upper cretaceous formations, from the barrémien up to the lower aturien, were missing in Baluchistán. I do not wish by any means to say that these stages are not represented there,—in fact there is reason to believe that they are developed in parts hitherto unsurveyed.

The fauna afforded a double interest when it was discovered, that except one species of pelecypod, which was new, the remainder could be identified with well known neocomian belemnites. These are :

Belemnites subfusiformis, Raspail.

Belemnites latus, Blainville.

Belemnites dilatatus, Blainville.

Belemnites pistiliformis, Raspail.

Small as the number may be, it is quite sufficient to fix with the greatest accuracy the age of the belemnite shales, which must now be considered to be of neocomian age, and most probably they represent the étage hauterivien of the French geologists.

I.—PELECYPODA.

Order : ANISOMYARIA.

Family : *OSTREIDÆ*

Genus : *GRYPHÆA*, Lam.

GRYPHÆA OLDHAMI, spec. nov., plate I, figs. 1-1e, 2-2b, 3-3b.

This pretty little species hardly ever grows longer than 30mm., its width varying somewhat between 20 and 22mm. The left valve, which is much larger than the right one, is narrow, somewhat triangular in shape, and strongly inflated, generally dropping steeply in both the anterior and posterior directions; the posterior side is

usually expanded into a short wing; the umbo is thick, generally prominent and incurved, and, if there are no marks of fixing, slightly reversed at the apex; a more or less distinct furrow runs down the posterior side; ligamental pit triangular and long. Surface somewhat foliaceous, otherwise smooth. Marks of fixing usually rather large.

Left valve small, irregularly oval, flat or lightly concave, exceedingly thick at the umbonal region, but quickly becoming thinner in ventro-posterior direction; ligamental pit long and triangular; surface lamellous, covered with numerous strong striæ of growth.

Locality and stratigraphical position.—Sembar Pass, and range north of Ghora Dund; belemnite shales.

Remarks.—This nice little species is easily recognized by its peculiar shape; in typical specimens it appears as above described, but it varies a good deal in shape; the umbo of the left valve becomes less prominent and the right valve is frequently much thinner, but still the general character remains the same.

II.—CEPHALOPODA.

Order: BELEMNOIDEA.

A. PHRAGMOPHORA.

Family: *BELEMNITIDÆ*.

Subfamily: BELEMNITINÆ.

Genus: BELEMNITES, List.

1 Section: NOTOCOELI.

Group: DILATATI.

BELEMNITES (DUVALIA) DILATATUS, Blainville, plate II, figs. 1-1*b*, 2-2*b*, 3-3*b*, 4-4*b*, 5-5*b*, 6-6*b*, 7-7*b*.

1827. *Belemnites dilatatus*, Blainville, Mémoire sur les Bélemn., page 99, pl. 3, fig. 13; pl. 3, fig. 18. (For synonyms see Duval-Jouve, Belemnites, page 54.)

The guard varies considerably in shape; in fact there are hardly two specimens which are exactly alike; its general shape is elongated, but always strongly compressed laterally; transversely elliptical, rounded or acuminate at the posterior end, but always with a short point. In some instances it is posteriorly expanded, tapering towards the anterior end, while in others the posterior region is narrow, the anterior broad. The sides are generally flattened, but sometimes they are slightly tumid. The ventral side is rounded, narrow, undulating or straight; the dorsal side broadly rounded and convex. Ventral canal narrow and comparatively short. Sides marked by a double, somewhat indistinct dorso-lateral furrow. Transverse sections varying, but generally elliptical. Alveolar cavity not observed.

Locality and stratigraphical position.—Mazár Drik, Sembar pass, Béji valley, Sonari hill, Dunghán mountain; belemnite shales.

Remarks.—The specimens under examination are not well preserved, as in no case can the alveolar cavity be observed; they chiefly represent fragments of varying size of the posterior part of the guard, but these are quite sufficient to establish the identity of this species. *Belemnites (Duvalia) dilatatus* is particularly distinguished from others by the strong lateral compression of its shape, the short ventral canal, and the double dorso-lateral furrow—features which are well exhibited in the specimens under examination.

As already stated, it varies considerably in regard to its shape; younger specimens seem to be more lanceolate than older ones, which become broader, and as the grade of compression also varies a good deal, the transverse sections vary greatly, as may be seen from the figures, but the chief characters as above defined can always be recognized.

It is therefore established beyond doubt that this well known species from the French neocomian is also represented in Baluchistán, where it appears in as great a number of varieties as elsewhere.

BELEMNITES LATUS, Blainville, plate I, figs. 15-15a.

1828. *Belemnites latus* Blainville, Mém. sur les Bélemn., 121, pl. 5, fig. 4.

There is only a single specimen which I can refer doubtfully to the above-named species. The elongated guard measures about 55mm. in length, but it is not complete at either end. Apparently it was slightly compressed in a lateral direction. The ventral canal is extremely long and extends quite close to the posterior end. Cross section nearly circular at the posterior and elliptical at the anterior end.

Locality and stratigraphical position.—Jali, Robdár, Bolán pass; belemnite shales.

Remarks.—It was chiefly on account of the long ventral canal that I have referred this form to *Belemnites latus*, Bl., but it is impossible to be certain of a determination based on a single specimen, which is in addition considerably damaged. In its general shape, but particularly in regard to the length of the canal, it agrees with the figures given by d'Orbigny and Duval; but more and better preserved material is required to set the above determination beyond doubt. There is of course no reason why *Belemnites latus* should not also occur in Baluchistán, when those forms with which it is associated in southern France, have been already recognised there.

2. GASTROCOELI.

Group: HASTATI.

BELEMNITES PISTILLIFORMIS, Blainville, plate II, figs. 8-8b, 9-9a, 10-10a, 11-11a.

1827. *Belemnites pistilliformis*, Blainville, Mém. sur les Bélemn., p. 98, pl. 5, fig. 14. (For synonyms see Duval-Jouve, *Belemnites*, page 72.)

Guard tolerably long (the best preserved specimen measures 60 mm. in length), inflated at the posterior end, tapering or cylindrical towards the anterior end; posterior end slightly acuminate and pointed. Ventral canal very short. Cross sections almost circular. Apical line straight and central.

Locality and stratigraphical position.—Sonari hill, Khattan, Mazár Drik, Sembar pass, Tal Chotiali, Dunghán mountain; belemnite shales.

Remarks.—This species is characterized by its circular cross section, the shortness of the ventral canal, and the spherical posterior end, provided with a short point. In these features the specimens from Baluchistán agree so well with those from southern France that there is not the slightest doubt as to their identity.

This species is a little less common than *Belemnites subfusiformis* and *Belemnites dilatatus*, and with one exception only all the specimens under observation are very badly preserved.

BELEMNITES SUBFUSIFORMIS, Raspail, plate I, figs. 4-4a, 5-5a, 6-6a, 7-7b, 8-8a, 9-9a, 10-10a, 11-11a, 12-12a, 13-13a, 14-14a.

1829. *Belemnites subfusiformis*, Raspail, Hist. Nat. des Bélemn., p. 55, pl. 8, fig. 93.

This is the most common species in the Baluchistán belemnite shales, but not one of the specimens is complete; it is mostly found in fragments of a few centimetres in length, the longest being 63 mm., or, if the specimen described as var. *Baluchistanensis* really represents a variety of this species, the longest fragment measures 83 mm. without a trace of the alveolar cavity being visible.

The guard is elongated and slender, the diameter in the two longest fragments being about $\frac{1}{7}$ of their length. The under part of the guard is cylindrical and by tapering slowly in the posterior direction its posterior end becomes sharply acuminate. The ventral canal is short and narrow, its edges are rounded. The cross-section is circular; the apical, canal straight, slightly eccentric, and nearer the ventral side. The alveolar cavity is slightly eccentric and narrow, but comparatively long.

A double dorso-lateral furrow is always distinctly visible in the better preserved specimens. This species frequently exhibits a peculiarity which has been previously noticed in other species,—for instance, *Belemnites latus*, Bl., or *Belemnites bipartitus*, Bl. The surface of the guard presents a curious perforated appearance. In the Baluchistán specimens these perforations prove to be minute elliptical holes, barely exceeding 1 mm. in length, the longitudinal axis of which generally runs in antero-posterior direction; in some cases it deviates slightly, but I never observed any of the holes transversely directed. These holes are very shallow and are only found on the superficial layer of the guard; I have never observed them in any of the previous layers. As they cover the whole surface very evenly, and as they are always separated from each other by a distance of not less than their own length, and usually more, the appearance of a specimen covered with these holes is rather peculiar. When not filled out with matrix the holes are perfectly empty, and it is therefore extremely difficult to imagine to what agency their origin must be attributed. Of course the action of boring mollusca or annelids seems to give the most

natural explanation and Duval-Jouve has discussed this question on page 26 of the memoir quoted, without, however, arriving at a satisfactory conclusion. To me it seems beyond any doubt that these holes are produced by some sort of a parasite, not improbably during the animal's life, and that they have nothing whatever to do with the structure of the guard.

Varieties.—*Belemnites subfusiformis* includes a number of varieties which are chiefly remarkable by the varying proportion of the length to the diameter of the guard. On plate I, fig. 13, two fragments of a specimen are figured, which was certainly not under 60 mm. in length, while its largest diameter measured slightly over 5 mm.; fig. 11, on the other hand, measuring 62 mm. in length, has a diameter of nearly 11 mm. As this observation has already been made by previous authors, it is useless to dwell longer on it; it will be sufficient to say that *Belemnites subfusiformis* from Baluchistán forms no exception in this respect. It may, however, be useful to describe in more detail some fragments of a large species which I have referred with some doubt to this species as var. *Baluchistanensis*, but which might perhaps represent a new form. Unfortunately they are too badly preserved to decide this question. It is sufficient to draw attention to the fact that this species—if it is really only a variety of *Belemnites subfusiformis*—must have attained a considerable size in Baluchistán. The two largest fragments measure 83 mm. in length without any trace of the ventral canal or alveolar cavity being visible. The largest diameter below the plane of fracture measures 19 mm., at the anterior broken end it measures 16 only. In general shape they resemble *Belemnites subfusiformis*, but we may suppose that the guard tapered slightly towards the anterior and more rapidly towards the posterior end.

These specimens have been chiefly found in a bed of what is probably volcanic ash, which has apparently somewhat affected their surfaces: under these circumstances nothing can be said for the present as to the dorso-lateral furrows, whether such were present or not, and the whole question of the identity of these large specimens must be left open until further and better preserved material has been procured.

Locality and stratigraphical position.—Chappar Rift, Sembar pass, Béji valley, Bolán pass, Sonari hill, Dughán mountain; var. *Baluchistanensis*, Jali, Robdar valley, in volcanic ash.

Remarks.—As I was able to compare typical specimens of *Belemnites subfusiformis* from Castellane with those collected in Baluchistán, I could convince myself of the identity of both forms, which differ only in the mode of preservation the guard of the Baluchistán specimens being black, those from Castellane brown; otherwise it would be difficult to tell one from the other. *Belemnites subfusiformis* is the most common species in Baluchistán and far exceeds the other forms in frequency of occurrence.

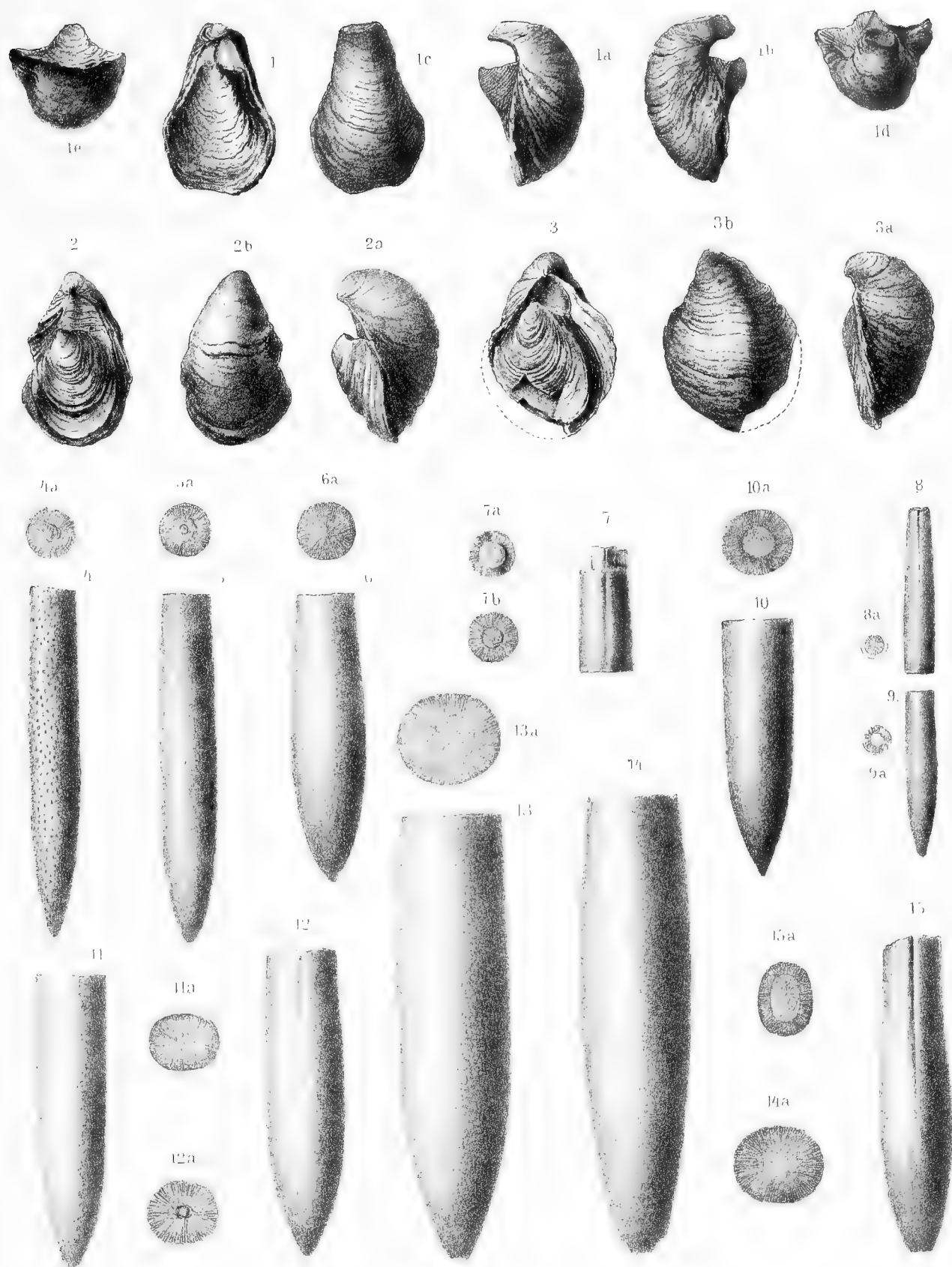
PLATE I.

- Fig. 1. *GRYPHÆA OLDHAMI*, spec. nov., Belemnite shales, Sembar pass.
 Fig. 1a. " " " anterior view.
 Fig. 1b. " " " posterior view.
 Fig. 1c. " " " left valve, outer side.
 Fig. 1d. " " " umbonal view.
 Fig. 1e. " " " ventral view.
 Fig. 2. *GRYPHÆA OLDHAMI*, spec. nov., Belemnite shales, S. of Marmand.
 Fig. 2a. " " " anterior view.
 Fig. 2b. " " " left valve, outer side.
 Fig. 3. *GRYPHÆA OLDHAMI*, spec. nov., Belemnite shales, S. of Marmand.
 Fig. 3a. " " " posterior view.
 Fig. 3b. " " " left valve, outer side.
 Fig. 4. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Béji valley.
 Fig. 4a. " " " cross-section.
 Fig. 5. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Béji valley, ventral side.
 Fig. 5a. " " " cross-section.
 Fig. 6. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Sembar pass.
 Fig. 6a. " " " cross-section.
 Fig. 7. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Sembar pass, ventral side.
 Fig. 7a. " " " cross-section, anterior end.
 Fig. 7b. " " " posterior end.
 Fig. 8. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Bolàn pass.
 Fig. 8a. " " " cross-section.
 Fig. 9. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Bolàn pass.
 Fig. 9a. " " " cross-section.
 Fig. 10. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Béji valley.
 Fig. 10a. " " " cross-section.
 Fig. 11. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Sembar pass.
 Fig. 11a. " " " cross-section.
 Fig. 12. *BELEMNITES SUBFUSIFORMIS*, Rasp., Belemnite shales, Sonari hill.
 Fig. 12a. " " " cross-section.
 Fig. 13. *BELEMNITES SUBFUSIFORMIS*, Rasp., var. *BALUCHISTANENSIS*, Belemnite shales, Jali, Robdar, Bolàn pass.
 Fig. 13a. " " " Belemnite shales, Jali, Robdar, Bolàn pass, cross-section.
 Fig. 14. *BELEMNITES SUBFUSIFORMIS*, Rasp., var. *BALUCHISTANENSIS*, Belemnite shales, Jali, Robdar, Bolàn pass.
 Fig. 14a. " " " Belemnite shales, Jali, Robdar, Bolàn pass, cross-section.
 Fig. 15. *BELEMNITES LATUS*, Blain., Belemnite shales, Jali, Robdar, Bolàn pass, ventral side.
 Fig. 15a. " " " lateral view.

CRETACEOUS FOSSILS OF BALUCHISTÁN.

Pl. I

Geological Survey of India.

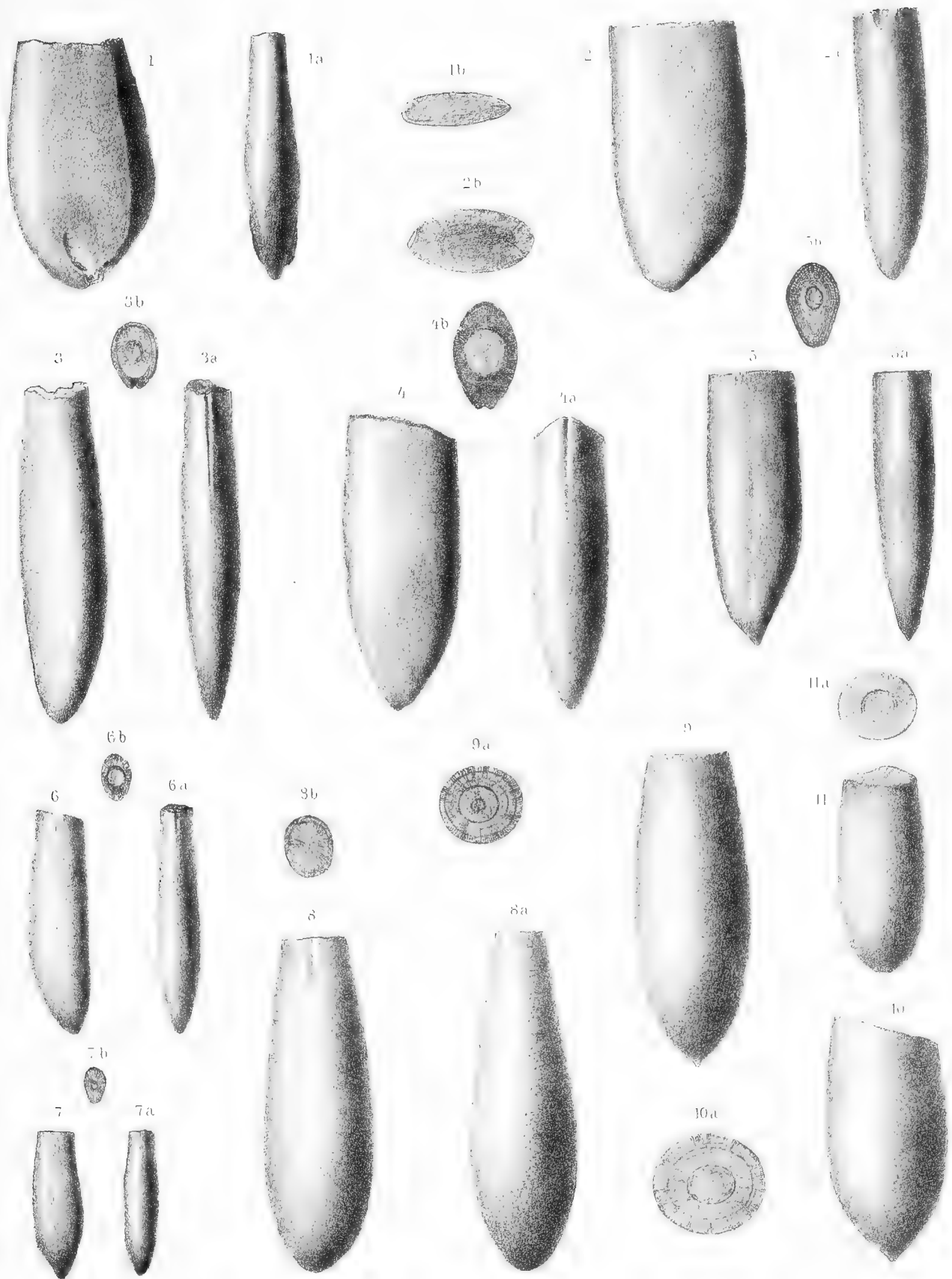


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PLATE II.

- | | | |
|-----------|--|--|
| Fig. 1. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Béji valley. |
| Fig. 1a. | " | " dorsal side. |
| Fig. 1b. | " | " cross-section. |
| Fig. 2. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Béji valley. |
| Fig. 2a. | " | " dorsal side. |
| Fig. 2b. | " | " cross-section. |
| Fig. 3. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Sonari hill. |
| Fig. 3a. | " | " ventral side. |
| Fig. 3b. | " | " cross-section. |
| Fig. 4. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Dunghàn mountain. |
| Fig. 4a. | " | " ventral side. |
| Fig. 4b. | " | " cross-section. |
| Fig. 5. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Sembar pass. |
| Fig. 5a. | " | " ventral side. |
| Fig. 5b. | " | " cross-section. |
| Fig. 6. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Sonari hill. |
| Fig. 6a. | " | " dorsal side. |
| Fig. 6b. | " | " cross-section. |
| Fig. 7. | BELEMNITES (DUVALIA) | DILATATUS, Blain., Belemnite shales, Sonari hill, young species. |
| Fig. 7a. | " | " dorsal side. |
| Fig. 7b. | " | " cross-section. |
| Fig. 8. | BELEMNITES PISTILLIFORMIS, Blain., Belemnite shales, Sonari hill, | ventral side. |
| Fig. 8a. | " | " side view. |
| Fig. 8b. | " | " cross-section. |
| Fig. 9. | BELEMNITES PISTILLIFORMIS, Blain., Belemnite shales, Dunghàn mountain. | |
| Fig. 9a. | " | " cross-section. |
| Fig. 10. | BELEMNITES PISTILLIFORMIS, Blain., Belemnite shales, Sembar pass. | |
| Fig. 10a. | " | " cross-section. |
| Fig. 11. | BELEMNITES PISTILLIFORMIS, Blain., Belemnite shales, Béji valley. | |
| Fig. 11a. | " | " cross-section. |



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FAUNA OF BALUCHISTAN.

Vol. I, Part 3.

FAUNA OF THE UPPER CRETACEOUS (MAËSTRICHTIEN) BEDS
OF THE MARI HILLS

By FRITZ. NOETLING, Ph.D.,
Palaeontologist Geological Survey of India.

Plates I—XXIII.

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FAUNA OF BALUCHISTAN

Vol. I, Part 3.

FAUNA OF THE UPPER CRETACEOUS (MAËSTRICHTIEN) BEDS
OF THE MARI HILLS.

INTRODUCTION.

The description of the fauna of the upper cretaceous strata completes the first volume of series xvi, and it may safely be said that the species described on the following pages are of special interest, inasmuch as they shed quite a new light on the geographical distribution of the upper cretaceous fauna.

The following description includes 77 species, but it is quite certain of course that this number does not include the entire fauna of the uppermost cretaceous beds in Baluchistán. Our knowledge of the geology of that country is in its infancy, and it is more than probable that with the increase of our knowledge of it, more forms will be added to those described here. However, they are quite sufficient to admit of some general conclusions being drawn. The following species were identified :

1. *Orbitolites macropora*, DeFrance.
2. *Orbitoides socialis*, Leymerie.
3. *Trochomilia protectans*, spec. nov.
4. *Cyclolites medlicotti*, spec. nov.
5. „ *regularis*, Leymerie.
6. *Cidaris suleimani*, spec. nov.
7. *Orthopsis perlata*, spec. nov.
8. *Cyphosoma*, spec.
9. *Protechinus paucituberculatus*, spec. nov.
10. *Echinoconus gigas*, spec. nov.
11. *Holotypus baluchistanensis*, spec. nov.
12. *Pyrina ataxensis*, Cotteau.
13. „ *gigantea*, spec. nov.
14. *Echinanthus griesbachi*, spec. nov.
15. *Cyclolampas helios*, spec. nov.
16. „ *vishnu*, spec. nov.
17. *Hemipneustes pyrenaicus*, Hébert.
18. „ *leymeriei*, Hébert.
19. „ *compressus*, spec. nov.
20. *Hemiaster blanfordi*, spec. nov.
21. „ *oldhami*, spec. nov.
22. *Ostrea acutirostris*, Nilsson.
23. „ *pectinata*, Lamarck.
24. „ *ungulata*, Schlotheim.
25. *Gryphæa vesicularis*, Lamarck.
26. *Exogyra pyrenaica*, Leymerie.
27. *Spondylus santoniensis*, d'Orbigny.
28. „ *spec. indet.*

FAUNA OF BALUCHISTÁN.

29. *Hinnites* (?) *foliaceus*, spec. nov.
30. *Vola quinqueangularis*, spec. nov.
31. „ *quadricostata*, Sowerby.
32. *Pecten dujardini*, Roemer.
33. *Modiola*, spec. indet.
34. „ *vishnu*, spec. nov.
35. *Cardita beaumonti*, d'Arch. and Haime, var. *baluchistanensis*, Noetl.
36. „ *subcomplanata*, d'Arch. and Haime.
37. *Cardium loralaense*, spec. nov.
38. „ *harnaiense*, spec. nov.
39. *Cyprina mazariana*, spec. nov.
40. „ *desensis*, spec. nov.
41. *Roudairia crassoplicata*, spec. nov.
42. *Chama callosa*, spec. nov.
43. *Radiolites subdilata*, Muschketoff sp.
44. „ *muschketoffi*, spec. nov.
45. *Pholadomya indica*, spec. nov.
46. „ *tigris*, spec. nov.
47. *Corbula harpa*, d'Archiac and Haime.
48. *Trochus bartetianus*, Leymerie.
49. *Nerita pontica*, d'Archiac spec.
50. „ *archiaci*, spec. nov.
51. *Turritella*, spec. 1.
52. „ spec. 2.
53. „ (?) *quinquecostata*, spec. nov.
54. *Calyptraea* spec.
55. *Nerinea quettaensis*, spec. nov.
56. „ *ganesha*, spec. nov.
57. *Cerithium vishnu*, spec. nov.
58. „ *buddha*, spec. nov.
59. „ spec.
60. *Pugnellus crassicosatus*, spec. nov.
61. „ *digitatus*, spec. nov.
62. „ *giganteus*, spec. nov.
63. *Ovula expansa*, d'Archiac and Haime.
64. „ *baluchistanensis*, spec. nov.
65. *Strigatella* sp.
66. *Voluta* sp.
67. „ *pseudocostata*, spec. nov.
68. *Volutilithes latisepta*, Stoliczka,
69. „ *dubia*, spec. nov.
70. *Volutomorpha* spec.
71. *Conus* sp.
72. *Nautilus sublaevigatus*, d'Orbigny.
73. *Nautilus subpleuricusianus*, d'Arch. and Haime,
74. *Indoceras baluchistanensis*, spec. nov.
75. *Sphenodiscus acutodorsata*, spec. nov.
76. *Baculites binodosus*, spec. nov.
77. *Ranina griesbachi*, spec. nov.

Out of these 77 species 66 have been specifically described, while of the remaining 11 the genus only could be determined. I admit this is rather a high percentage, but I think it much better to refrain from the specific determination of specimens which are only known as fragments. I much deprecate the practice of many modern authors who create new species, new genera, even new families, on fragments which show so few distinguishing features, that uncertainty prevails as to the main characters of species thus created.

Out of the remaining 66 species 42 have been recognized as new, while 24 species could be identified with forms previously described. It is quite clear that the chief interest rests with these 24 species, which are :—

1. *Orbitolites macropora*, DeFrance.
2. *Orbitoides socialis*, Leymerie.
3. *Cyclolites regularis*, Leymerie.
4. *Pyrina ataxensis*, Cotteau.
5. *Hemipneustes pyrenaicus*, Hébert.
6. *Hemipneustes leymeriei*, Hébert.
7. *Ostrea acutirostris*, Nilsson.
8. *Ostrea pectinata*, Lamarck.
9. *Ostrea unguolata*, Schlotheim.
10. *Gryphæa vesicularis*, Lamarck.
11. *Exogyra pyrenaica*, Leymerie.
12. *Spondylus santoniensis*, d'Orbigny.
13. *Vola quadricosta*, Sowerby.
14. *Pecten dujardini*, Rømer.
15. *Cardita beaumonti*, d'Arch. and Haime, var. *baluchistanensis*, Noetl.
16. *Cardita subcomplanata*, d'Arch. and Haime.
17. *Radiolites subdilata*, Muschketoff.
18. *Corbula harpa*, d'Arch. and Haime.
19. *Trochus lartetianus*, Leymerie.
20. *Nerita pontica*, d'Arch. spec.
21. *Ovula expansa*, d'Arch. and Haime.
22. *Volutilithes latisepta*, Stoliczka.
23. *Nautilus sublaevigatus*, d'Orbigny.
24. *Nautilus subfleuriansianus*, d'Arch. and Haime.

It will be convenient to exclude for a moment those species which are hitherto only known to occur in Indian or Central Asian beds ; these are :—

1. *Cardita beaumonti*, d'Arch. and Haime, var. *baluchistanensis*, Noetl.
2. *Cardita subcomplanata*, d'Arch. and Haime.
3. *Radiolites subdilata*, Muschketoff.
4. *Corbula harpa*, d'Arch. and Haime.
5. *Ovula expansa*, d'Arch. and Haime.
6. *Volutilithes latisepta*, Stoliczka.
7. *Nautilus subfleuriansianus*, d'Arch. and Haime.

There remain, therefore, 17 species, or 26 per cent. of the total number, which the Baluchistán upper cretaceous beds have in common with the cretaceous beds of Europe ; and it is clear that it is these forms which we have chiefly to consider in

seeking information with regard to the age and correlation of the *Hemipneustes* beds, as they may be conveniently styled. The following table will show the geological distribution of these 17 species :—

| | SENONIAN. | |
|--|------------------------|---------------------|
| | Lower (Emschérien). | Upper (Aturien). |
| 1. <i>Orbitolites macropora</i> , Def. . . . | | + |
| 2. <i>Orbitoides socialis</i> , Ley. . . . | | + |
| 3. <i>Cyclolites regularis</i> , Ley. . . . | | + |
| 4. <i>Pyrina ataxensis</i> , Cott. . . . | | + |
| 5. <i>Hemipneustes pyrenaicus</i> , Héb. . . . | | + |
| 6. „ <i>leymeriei</i> , Héb. . . . | | + |
| 7. <i>Ostrea acutirostris</i> , Nils. . . . | + | + |
| 8. „ <i>pectinata</i> , Lamarek | + | + |
| 9. „ <i>ungulata</i> , Schloth. . . . | | + |
| 10. <i>Gryphæa vesicularis</i> , Lamarek | | + |
| 11. <i>Exogyra pyrenaica</i> , Leym. . . . | | + |
| 12. <i>Spondylus santoniensis</i> , d'Orb. . . . | (?) | + |
| 13. <i>Vola quadricostata</i> , Sow. . . . | , | + |
| 14. <i>Pecten dujardini</i> , Roemer | + | + |
| 15. <i>Trochus lartetianus</i> , Leym. . . . | | + |
| 16. <i>Nerita pontica</i> , d'Arch. . . . | (?) | + |
| 17. <i>Nautilus sublaevigatus</i> , d'Orb. . . . | (?) | + |

From the above list it is unquestionable that the *Hemipneustes* beds of Baluchistán are of Senonian age, representating the upper part or étage Aturien of that formation.

The only question to be considered now would be, to which of the two subdivisions of the Aturien, the lower or Campanien or the upper or Maëstrichtien, the *Hemipneustes* beds might be correlated. If such a specialization is admissible for countries as far distant as Baluchistán and Western Europe, the evidence is all more in favour of the Maëstrichtien than of the Campanien.

In fact, if we consider that the chief development of the genus *Hemipneustes* takes place in the étage Maëstrichtien, and if we further consider that the genus

Orbitoides holds a similar position, this view of the correlation of the Baluchistán Hemipneustes beds becomes almost a certainty.

We may therefore take it for granted that the Hemipneustes beds are of uppermost cretaceous age, and that they are most probably homotaxial to the étage Maëstrichtien of the French authors.

Having thus ascertained the age of the Hemipneustes beds, we may turn back to India and examine the stratigraphical position of the seven species known to occur in cretaceous beds in other localities in India, and see how far the view gained above tallies with the result obtained from the examination of these seven species. Of course the view thus gained must be considered to be preliminary only, as seven species can hardly be taken as sufficient evidence for an exact determination.

It may perhaps be better to exclude *Cardita beaumonti*, var. *baluchistanensis*, because, as I have pointed out on page 46, the Baluchistán variety is not quite identical with the typical *Cardita beaumonti*, d'Arch. and Haime, from Sind. From the remaining species the following have been found in the *Cardita beaumonti* beds :—

Cardita subcomplanata, d'Arch. and Haime.

Corbula harpa, d'Arch. and Haime.

Ovula expansa, d'Arch. and Haime.

Nautilus subfleuriusianus, d'Arch. and Haime.

To which we may add *Nautilus sublævigatus*, d'Orbigny, described as *Nautilus labechi* by Messrs. d'Arch. and Haime, so that the total number of species in common with the *Cardita beaumonti* beds amounts to five.

This is certainly no large number, and indicates only a distant connection; in fact the connection between the beds of the same age in the far distant Pyrenees and the Hemipneustes beds of Baluchistán seems to be much greater, as will presently be seen, than that between the latter and the comparatively near country of Sind. It must not, however, be overlooked that the fauna of the *Cardita beaumonti* beds is very imperfectly known, inasmuch as only the corals and echinoids have been determined. But from these investigations the undeniable fact appears that no single species of both classes is common to the Hemipneustes and the *Cardita beaumonti* beds. This seems to me significant, and if we further take into consideration that the *Cardita beaumonti* beds have hitherto yielded no ammonites, the natural conclusion that the *Cardita beaumonti* and the Hemipneustes beds hold different positions in the sequence of the strata suggests itself. With every reserve I wish to express my opinion that the *Cardita beaumonti* beds are decidedly younger than the Hemipneustes beds and hold a higher position than the latter in the sequence of the cretaceous beds of Sind and Baluchistán.

With regard to the remaining two species, viz., *Radiolites subdilata*, Muschketoff, and *Volutilithes latisepta*, Stoliczka, the former occurs in strata of Senonian age in Turkestan and the latter in the Ariyalúr stage of Southern India.

We see, therefore, that the outcome of the critical examination of this species is

quite in harmony with the results deduced from the examination of the species identified with European forms. There is no evidence whatsoever to indicate an age lower than Senonian for the Hemipneustes beds.

Having thus ascertained the age which must be attributed to the Hemipneustes beds of Baluchistán, the relations which they hold to beds of similar age at other parts of the globe remain to be examined.

The most natural locality for comparison is of course that of Ariyalúr in Southern India; the following species have been found common to Baluchistán and Southern India.

1. *Vola quadricostata*, Sow.
2. *Gryphæa vesicularis*, Lam.
3. *Ostrea (Alectryonia) pectinata*, Lam.
4. *Ostrea (Alectryonia) unguolata*, Schloth.
5. *Ostrea acutirostris*, Nils.
6. *Volutilithes latisepta*, Stoliczka.

That is to say, the two localities share not more than six species in common, out of which the first five are ubiquitous forms which occur wherever upper cretaceous beds are developed; they are therefore of no consequence whatsoever. The only Southern Indian species, which also occurs in Baluchistán, is *Volutilithes latisepta*, Stol., of whose identity with Stoliczka's original I have satisfied myself by direct comparison. None of the numerous species indigenous to Southern India occur in Baluchistán. It may perhaps be supposed that in Southern India beds of the horizon of the Hemipneustes bed are not developed, but this view seems scarcely probable, although it requires further examination. Mr. Levillé¹ has expressed himself very decidedly on this point, by separating the Niniyur beds as the top-most cretaceous stage from the Ariyalúr stage. But as yet no list of fossils from the Niniyur beds is known, Stoliczka's list including of course the species of both the Ariyalúr and Niniyur beds, so nothing definite can be said for the present; but we may take it as established that a comparison of the fauna of the upper cretaceous beds in Southern India with that of the Hemipneustes beds in Baluchistán is admissible.

This comparison shows unquestionably that there is not the slightest faunistic similarity between the upper cretaceous beds of Southern India and Baluchistán. In fact the difference of the composition of both faunas is as wide as it possibly can be. I refrain from a comparison with the cretaceous beds in Central India, etc., because their fauna has not been sufficiently studied as yet, and it appears also that no strata above Cenomanian are developed in those parts.

As regards Western India and Turkistán, the relations between the Hemipneustes and *Cardita beaumonti* beds have already been discussed. There remains, therefore, only Turkistán, with which the Baluchistán Hemipneustes beds share only one species in common, viz., *Radiolites subdilata*, Musch. It appears, however, that strata of the same age as the Hemipneustes beds are not developed in that part of Turkistán, of which the fauna has been described by Muschketoff, and that

¹ Bulletin de la Soc. Géol. de France, ser. iii, XVIII. 146.

therefore a comparison of both faunas is inadmissible. There is, however, a strong indication of the existence of the uppermost cretaceous beds in Russian Turkistán as shown by the discovery by Mr. Cotteau of *Coraster vilanovæ*.¹ I must therefore leave it to be determined how far the similarity extends between the *Coraster vilanovæ* beds of Turkistán and the *Hemipneustes* beds of Baluchistán, and content myself for the present with having drawn attention to this fact.

The upper cretaceous beds of Asia Minor share only a few species with the *Hemipneustes* beds. The fauna of the upper cretaceous beds of the south-western corner of France bears a strong resemblance to that of the *Hemipneustes* beds of Baluchistán. Except such ubiquitous forms as *Vola quadricostata*, etc., the following species are common both to the Maëstrichtien of south-western France and the *Hemipneustes* beds of Baluchistán:

Orbitolites macropora, Def.
Orbitoides socialis, Ley.
Cyclolites regularis, Ley.
Pyrina atarensis, Cott.
Hemipneustes pyrenaicus, Heb.
Hemipneustes leymeriei, Heb.
Exogyra pyrenaica, Ley.
Trochus lartetianus, Ley.
Nerita pontica, d'Arch.

and probably also

Nautilus sublævigatus, d'Arch.

It is certainly highly remarkable, that even if we exclude the first and last two species, as occurring elsewhere in similar strata, there are certainly six species which have hitherto only been observed in the upper cretaceous beds of southern France and the *Hemipneustes* beds of Baluchistán. This seems to point to similar physical conditions under which the upper cretaceous beds were deposited in south-western France and Baluchistán. Another most remarkable fact is that the *Hemipneustes* beds do not share a single specimen with the upper cretaceous beds of Palestine and North Africa. It may be doubtful whether strata of the age of the *Hemipneustes* beds are developed in Palestine, but they certainly occur in North Africa.

These considerations lead us to the conclusion that the *Hemipneustes* beds are of upper Senonian age and most probably represent the étage Maëstrichtien. The fauna therein contained bears hardly any resemblance to the fauna of similar age in Southern India or Northern Africa. On the other hand it exhibits the closest relationship to the fauna contained in beds of similar age of south-western France. The fauna of the *Hemipneustes* beds must therefore be considered as belonging to the European province of the upper cretaceous sea, living probably in close proximity to its eastern shores. This sea was most probably divided by a comparatively narrow land barrier from the sea in which the upper cretaceous fauna of Southern India lived, a view first expressed by Dr. Blanford and not, as I erroneously stated² by the late Professor Neumayr.

¹ Bulletin de la Soc. Géol. de France, ser. iii, XVII, 155.

² Records, Geological Survey of India, 1894, XXVII, 129.

PROTOZOA.

I. Class : RHIZOPODA.

Order : FORAMINIFERA.

Family : NUMMULINIDÆ.

Genus : ORBITOIDES, d'Orbigny.

ORBITOIDES SOCIALIS, Leymerie. Pl. I, fig. 1-1*a*, 2-2*c*, 3-3*c*, 4-4*d*.

1851. *Orbitolites Leymerie*, Sur un nouveau type Pyren.: Mem. Soc. Géol. de France, ser. ii, IV, 191, pl. A, fig. 5.

The disciform test is sometimes rather irregular but always thin, with a sharp cutting margin. The largest specimen has a diameter of 12 mm., but the average is about 7 mm. Generally both sides are convex, but sometimes one is a little more so than the other, and in this case one is almost flat. The thickness of the test varies therefore considerably, and it is not always the largest specimen which is thickest. The centre of each side is raised into a low rounded mamelon, that of the upper side being usually larger. Both sides are covered with a very fine, shagreen-like ornamentation, which, however, easily wears off.

Locality and stratigraphical position.—Dés valley, horizon 2.

Remarks.—Its general shape makes this species easily recognisable, and there is no doubt as to the identity of the Baluchistán forms with those of the Pyrenees, but it seems that in Baluchistán it undergoes certain variations with regard to the thickness of the test. There are, for instance, specimens which closely resemble *Orbitolites secans*, Leym., but which, on other hand, are so closely connected with the typical form, that it would be unjustifiable to consider them as separate species.

This species has also been found in Asia Minor,¹ where it holds a position similar to that in Baluchistán and the Pyrenees.

Family : MILIOLIDÆ.

Genus : ORBITOLITES, Lamk.

ORBITOLITES MACROPORA, DeFrance. Pl. I. 2-2*c*, 3-3*c*, 4-4*d*. fig. 5-5*b*, 6-6*b*.

1825. *Orbitolites Macropora*, DeFrance, Dict. des sc. natur., Vol. XXXVI, p. 295.

1851. *Orbitolites disculus*, Leymerie; Sur un nouveau type Pyr.: Mem. Soc. Géol. de France, ser. ii, Vol. IV, 191, pl. A, fig. 1.

1866. *Orbitolites macropora*, Tchihatcheff, Asie Mineure, Paleontologie, p. 103.

The thin test, which attains a diameter of about 10 mm., is orbicular, deeply concave in the central part of each side, but flattened along the periphery.

¹ Tchihatcheff. Asie Mineure, Paleontologie, p. 103.

When the upper layer of the shell is worn off, the arrangement of the internal chambers is exhibited; these are formed by the crossing of two systems of walls, a right and a left one. Along the margin the opening of several rows of tubuli can be seen.

Locality and stratigraphical position.—Dés valley, horizon 2.

Remarks.—The general shape of the test of this species is so characteristic that there can be hardly any doubt that the Baluchistán specimens are identical with this form, first discovered in the upper cretaceous system of the Pyrenees.

The generic position of *Orbitolites macropora* seems not quite certain; Leymerie, who described it as a new species under the name of *Orbitolites disculus*, has in his subsequent memoir on the Geology of the Pyrenees referred it to the genus *Orbitoides*. I take the view of d'Archiac, who thinks that it belongs to the genus *Orbitolites*, and that *O. disculus* Leymerie is identical with *Orbitolites macropora*. Defrance.

II. COELENTERATA.

Class: ANTHOZOA.

ZOANTHARIA.

Family: ASTRÆIDÆ.

Genus: TROCHOSMILIA.

TROCHOSMILIA PROTECTANS, spec. nov. Pl. I, fig. 7-7b, 8-8b, 9-9b, 10-10b.

| <i>Dimensions.</i> | | | | I. | II. | III. | IV. | V. | VI. |
|------------------------------------|--|--|--|----|-----|------|-----|----|--------|
| Height of corallum | | | | 66 | 47 | 38 | 41 | 33 | 22 mm. |
| Large diameter of calice | | | | 38 | 33 | 32 | 31 | 32 | 24 „ |
| Small diameter of calice | | | | 15 | 15 | 13 | 13 | 16 | 13 „ |

The corallum reaches a tolerably large size; but in the above figures the heights are a little too small, because the basal portion of the corallum, with which it was apparently attached to foreign bodies, is broken away in all specimens; it is simple cuneiform, compressed, and slightly curved in the direction of the small axis of the calyx. The basal portion is attenuated and the place for attachment very small. Younger individuals exhibit a somewhat different shape to that of full grown specimens, because at the earlier stages they grow more rapidly in breadth than in height. In the figures given above, specimens V and VI afford instances where the breadth of the corallum considerably surpasses its height—an observation which can

be made in nearly every individual. After a certain height has been attained the corallum increases quicker in height than in breadth: young specimens have therefore a triangular cross section in the direction of the larger diameter, while the section of a full grown specimen seems to be composed of two parts, a more rectangular upper and triangular basal portion.

The calyx is elliptical, and, as will be seen from the above figures, the large diameter is more than double the length of the short diameter. The corallum has therefore a markedly compressed shape. Fossula narrow, rather shallow and elongated. No columella. There are six complete cycles of septa, of which those of the first and second cycle are nearly equal in size, but much larger than the others. The septa are very thin, straight and closely set, their upper edge being granulated. Inferior part of the visceral chamber completely filled out by dissepiments. The surface is covered with straight, continuous, very delicate granular costæ of equal thickness at the upper margin of the calyx. Epithea rudimentary, in narrow bands, marking periods of stopping in the continuous growth of the corallum.

Locality and stratigraphical position.—Mazár Drik.

Remarks.—The peculiar shape of the corallum distinguishes this species easily from the other forms of this genus.

One of the specimens fig. 10a exhibits a curious phenomenon, which is rather difficult to explain in a specimen of 42 mm. in length. The basal portion of the corallum is broken off, and imbedded in the visceral chamber there is a complete specimen of a *Modiola*, resting in an oblique position, both valves still together, with the beaks turned downwards, of not less than 18 mm. in length, the breadth of the corallum being about 24 mm. From the foregoing remarks regarding the lower part of the visceral chamber which is completely filled up by dissepiments, it is impossible that the shell could have been imbedded in its present place as it is after the death of the animal, and it is equally impossible that the shell represents a species of *Lithophagus* which has bored into the corallum, because there is no sign of a hole in the wall of the corallum through which the shell could find its way into the visceral chamber. As there is also not the slightest indication of a bore hole in the calyx or anywhere above the place which the shell occupies, it seems to me unquestionable that the shell must have got into its present position during the life of the coral which eventually grew over it and imbedded it in the endotheca. It is difficult to say how the *Modiola* originally acquired its present position; it is not impossible that it led a parasitical life inside the visceral chamber till it was eventually imbedded in the endotheca and died.

Family : *THAMNASTRÆIDÆ*.

Genus : *CYCLOLITES*, Lamarck.

CYCLOLITES MEDLICOTTI, spec. nov. Pl. I, fig. 11-11b, 12-12b.

The corallum is circular in outline, sometimes rather ovate. The base is flat, even a little concave; the epithea is thin, marked with numerous concentric

rings, of which stronger and finer ones irregularly alternate. In the centre there is a slightly raised knob, from which fine lines radiate towards the periphery. The upper surface is very slightly convex, nearly flat, with a shallow oval depression in the centre. The septa are numerous, all very close, thin, straight and subequal, their edges being granulated.

Locality and stratigraphical position.—Dés Valley, upper cretaceous.

Remarks.—The diameter of this pretty little species is scarcely more than 25 mm., while its height never exceeds 4 mm. By its flat, depressed upper side, and the base marked by radiating striæ, this species is easily distinguished from *Cyclolites regularis*.

CYCLOLITES REGULARIS, Leymerie. Pl. I, fig. 13-13b, 14-14a.

1851. *Cyclolites semiglobosa*, Leymerie, Mem. de Soc. Geol. de France, ser. ii, IV, 199, pl. B, fig. 14.

1881. *Cyclolites regularis*, Leymerie, Mem. Géol. et Pal. des Pyrénées, p. 774.

The corallum is circular in shape; the upper surface nearly hemispherical, slightly depressed in the centre. The fossula is longitudinal, slit like, and very narrow. The septa are very numerous, thin, unequal and straight, their upper edges being probably granulated. The lower surface is flat, sometimes even concave, covered with a moderately thick, concentrically folded epitheca; in the centre is a more or less distinctly marked small circular knob.

Locality and stratigraphical position.—Sonári Valley, Mazár Drik.

Remarks.—This species is easily distinguished from the former by its hemispherical upper surface, and the absence of radiating striæ on the lower surface.

Although I am not quite certain whether the edges of the septa are granulated as in the original of *Cyclolites regularis*, Ley., I think that, to judge from the general shape, and particularly from the tumid upper surface, and the narrow slit-like fossula, the Baluchistán form must be identical with that from the Pyrenees.

III. ECHINODERMATA.

Class : ECHINOIDEA.

Subclass : EUECHINOIDEA.

Order : REGULARES.

Family : CIDARIDÆ.

Genus : CIDARIS, Klein.

CIDARIS SULEIMANI, spec. nov. Pl. II, fig. 1-1c.

Test circular, inflated, apparently equally depressed at both poles, ambulacral areas narrow and flexuous, slightly depressed; filled in the middle with two rows

of very closely set, transverse, small tubercles, each of which carry two or three rounded minute granules, of which the inner ones are smaller than the outer; the poriferous zones are composed of small rounded holes, which are surrounded by a low filiform ridge. This is, however, always much more distinctly developed in the outer row than in the inner one; the pores are arranged in horizontal pairs, which are separated by a low but sharp septum.

The interambulacral areas are wide and consist of rather narrow but high plates of which there are six in each row, decreasing in size towards the periproct and the apex, those at the equator being the largest. The tubercles are large and prominent, the mamillary eminence is apparently rounded and perforated, the boss is depressed and destitute of crenulations, the areola is large and encircled by a complete row of small granules.

The miliary zone is rather large, slightly depressed, and provided with numerous uniform small granules which are arranged in little, irregular, horizontal lines.

Peristome and opening for the apical disc not seen.

Locality and stratigraphical position.—Dés Valley, horizon 2: rare.

Remarks.—The peculiar ornamentation of the ambulacral area, consisting of two narrow rows of transversely elongated tubercles, which originate by the passing into each other of two or three separate rows, still indicated by the secondary granules, distinguishes this species from all the other known forms.

It shows, however, a close relationship to *Cideris mamillata*, Cotteau,¹ particularly as regards the narrow interporiferous zone of the ambulacral areas, and the rather small number of tubercles on the interambulacral areas. Unfortunately no enlarged figure of a part of the ambulacral area is given, and I am therefore unable to say whether the ornamentation is the same as in *Cidaris suleimani* or not. If it were the same the two species ought to be considered as identical.

Family: *GLYPHOSTOMATA*.

Subfamily: *DIADEMATIDÆ*.

Genus: *ORTHOPSIS*, Cotteau.

ORTHOPSIS PERLATA, spec. nov. Pl. II, fig. 2-2c.

Test circular, about 38 mm. in diameter, height about 12 mm., upper surface a little inflated, depressed; lower surface nearly flat, slightly pulvinated at the margin; apical disc pentagonal, rather small, composed of five large heptagonal genital plates perforated by large holes and five small pentagonal ocular plates perforated by minute holes; the madreporiform plate is a little larger than the other genital plates which bear a few small granules. Anal opening small, subhexagonal.

Ambulacral areas rather broad, but less than half the breadth of the interambulacral areas; poriferous zones straight, composed of small rounded pores; pores ar-

¹ *Paléontologie française; Terr. crétacé, Echinides*, p. 330 pl., 1079, figs. 11—14.

ranged in slightly oblique pairs; near the ambitus three pairs of pores are formed into obliquely placed groups; this arrangement disappears, however, towards the apex and mouth. Tubercles small, the mamillary eminence small and perforated, the boss comparatively large and not crenulated, the scrobicule narrow but deep, surrounded by a complete circle of secondary tubercles.

On the ambulacral area there are two very regular rows of tubercles, of which about one comes on every three ambulacral plates. There are about 30 tubercles in each row, which decrease in size from the equator to either pole; in the miliary zone there are two rows of secondary tubercles, between which there are some small granulations. On the interambulacral area there are two rows of primary tubercles, slightly larger than those of the ambulacral area, which extend from the apex to the mouth; on either side of each of these rows there are two rows of secondary tubercles, which do not reach up to the apex, but probably extend to the mouth; the two lines next to the primary row reach rather high up on the upper surface, but disappear before they reach the apex. As regards the relative size of the tubercles, those that compose the outer rows are a little smaller than those of the inner ones; fine granules are sparsely and irregularly distributed between the primary tubercles. Peristome unknown.

Locality and stratigraphical position.—Dés Valley, horizon 4.

Remarks.—The specimen above described is considerably damaged, but those parts which remain, exhibit the features sufficiently well to allow of its determination. The chief difficulty arises from the weathered state of the test, as it is not easy to decide whether the tubercles are perforated or not; a few tubercles, however, show minute holes, so that although no traces are left on the majority of them, it is quite certain that the tubercles were perforated and not crenulated.

Cotteau states¹ that the genus *Orthopsis* forms part of the Diadematiidæ, with perforated non-crenulated tubercles. Its chief features are the numerous small tubercles on the ambulacral and interambulacral areas and the regular straight ambulacral plates separated by conspicuous sutures, features which are well noticeable with the above specimen, so that there is no doubt as to its generic identity.

The nearest relation of *Orthopsis perlata* is *Orthopsis ovata*, Cott., which has, however, only 8 rows of tubercles on the interambulacral areas instead of the 10 of the Baluchistán species. *Orthopsis granularis*, Cott., and *Orthopsis miliaris*, Cott., sp., are distinguished by the still smaller number of rows of tubercles on the interambulacral areas and by their generally smaller size.

Genus : CYPHOSOMA, Agassiz.

CYPHOSOMA sp.

The only specimen by which this genus is represented is a small, much worn, and deformed test of 22 mm. in diameter, circular in shape, with a depressed upper surface and a slightly pulvinated lower surface; apical disc destroyed, ambulacral

¹ Paléontologie française; Terr. cret., Echinodermes, Vol. VII, p. 551.

areas nearly as broad as the interambulacral ones, poriferous zones a little undulating, composed of small pairs arranged in horizontal non-conjugated pores. Two rows of rather large tubercles, the same size on both the ambulacral and interambulacral areas. Mammillary eminence large, rounded, imperforate, boss low, depressed, crenulated, surrounded by an incomplete scrobicular circle of small granules, a few isolated granules in the miliary zones. Peristome large, round, with ten short incisions on the lower end of the five interambulacral areas.

Locality and stratigraphical position.—Dés Valley, horizon 2.

Remarks.—It is to be regretted that the specimen is too ill preserved to allow a specific determination; and considering the minute differences on which the numerous species belonging to this genus are founded, it would be rash to identify a specimen of which hardly more than the generic features can be ascertained.

Subfamily: ECHINIDÆ, Wright.

PROTECHINUS, gen. nov.

Test thin, large, circular in shape; upper surface highly inflated, conical; lower surface flat, slightly pulvinate at the margin.

Apical disc not very large, pentagonal; genital plates perforated by large holes; anal opening comparatively small.

Ambulacral areas less than half the breadth of the interambulacral ones, slightly convex; interambulacral areas broad and probably slightly convex in the centre.

Poriferous zones straight, rather narrow; pores small, rounded; each ambulacral plate carrying three pairs of pores, internal pair composed of minute holes; in the two external ones the holes are of much larger size, but equal in both pairs; outer pairs arranged in a zigzag line, at the internal angles of which are placed the minute internal pair. Tubercles small, but uniform in size, imperforated, non-crenulated, arranged in vertical rows, which are most numerous at the ambitus and decrease in number towards the apex and mouth, but remain more numerous on the lower than on the upper surface; two rows of tubercles on both ambulacral and interambulacral areas reaching up to the apex.

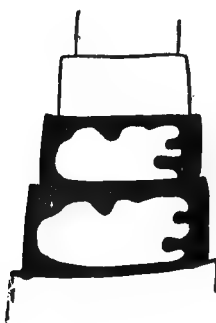
Periproct unknown.

Stratigraphical position.—Upper cretaceous series, Baluchistán.

Remarks.—I hesitated for some time as to whether I should consider this specimen as the type of a new genus or a species of the genus *Psammechinus*, with which it shows the closest relationship both in general shape and the peculiar arrangement of the pores. It differs, however, from all the known species belonging to the genus *Psammechinus*, Ag., in which genus the pores are all of equal size and seemingly arranged in groups of three pairs on each ambulacral plate obliquely inclined in apical direction, as can be seen on Desor's plate XVIII, fig. 2a

or 8a. On the other hand, the figures in the *Paléontologie française*, for instance plate 1201, fig. 4, or plate 1203, fig. 6—show distinctly that the triple groups of pairs of pores are formed not by the pores of one ambulacral plate, but by the pores of two consecutive plates. If we call the pairs of pores on one plate by numbers 1, 2, 3, 1 being the apical, 2 the median, 3 the peristomal pair, we find that the groups are composed of numbers 3, 1, 2, while the pairs on each plate are arranged in such a way that they form an irregular triangle, pair No. 2 being the most external, No. 3 the most internal one, and taken as a whole the pores are arranged in three rows, the external of which is formed by pairs No. 2, the median by pairs No. 1, and the internal one by pairs No. 3.

Now, in the specimen described below it will be noticed that the pores are seemingly arranged in groups of two, which are inclined in the direction of the peristome; the third pair, however, is so much reduced that it is hardly visible, but if of the same size as the former ones it would be the lowest in a group, which consists of pairs 2, 3, 1, of which 2 and 3 belong to one, 1 to the next following plate in the direction of the peristome. On each plate the pores are therefore arranged in such a way that pair 1 is the most internal pair, 2 the most external, and pair 3 the median one. The following diagram will show the arrangement of the pores on each plate, the arrangement of the pairs in triple groups, and the direction of inclination of each group in the genus *Psammechinus* and *Protechinus*.



The difference in the arrangement of the pairs of pores in the two genera is too conspicuous to be overlooked, and I think that it fully justifies the establishment of a new genus, considering besides that pair No. 1 has become obsolete.

How far the above rule as to the position of the pairs of pores on each ambulacral plate and their arrangement into groups applies to the other genera of the *Oligopori*, I am unable say for the present, but to judge from *Stomechinus denudatus*, Cott. (*Pal. franc.*, pl. 1204, fig. 4), this genus differs from the above two genera by a different arrangement of the pores, which are arranged in pairs inclined towards the peristome, in the order of 3, 1, 2, so that pairs No. 2 form the internal, 3 the external, and 1 the median row.

PROTECHINUS PAUCITUBERCULATUS, spec. nov. Pl. II. fig. 3-3A. Pl. III. fig. 1-1a.

The thin, large test is circular, having a diameter of not less than 95 mm.; the upper surface is highly inflated, apparently a little conical, the lower surface flat, slightly pulvinated at the margin.

Apical disc imperfectly known, but apparently not very large: anal opening small.

Ambulacral area not very broad, slightly convex, poriferous zones straight, rather broad and trigeminal, pores small, rounded and arranged in a peculiar fashion; the apical pairs of each plate, which form at the same time the inner row, are composed of two minute pores situated on a small elliptical plate, which looks as if it were jammed between two consecutive ambulacral plates; the two other pairs are composed of larger pores of the same size arranged at the four angles of a rhomboid.

Tubercles very small, but uniform in size, all over the test; the mammillary eminence is rounded, low, imperforate; the boss low, not crenulated, surrounded by a flat, rather large areola which is encircled by a low, smooth ridge.

On the ambulacral areas there are about 8 somewhat irregular rows of tubercles at the ambitus which, extending to the mouth, are reduced to about 4 on the upper surface; the rows gradually disappear until there remain only the two external ones which reach as far as the apical disc; on the interambulacral areas about 16 to 18 rows of tubercles may be counted at the ambitus; this number is, however, quickly reduced to about 4 near the mouth and 3 to 4 on the upper surface, of which, however, only two extend as far as the apex. The tubercles are arranged in horizontal lines on the interambulacral plates in such a way, that beginning from the apex the number of tubercles on each plate very slowly increases from 1 to about 9 near the ambitus, and then equally slowly decreases to about 4 near the mouth. Miliary zones perfectly smooth, except some minute sparsely distributed granules.

Periproct unknown, but apparently not very large.

Spines short, very thin and longitudinally striated.

Locality and stratigraphical position.—Upper cretaceous series, horizon 4, Dés Valley.

Remarks.—Unfortunately none of the specimens is completely preserved; the thin high conical test was apparently too weak to withstand pressure, and for this reason they are all more or less deformed. I am therefore unable to say whether it is an original feature that the interambulacral areas are slightly concave in the centre; it is quite possible that this may be so, and then it would be quite in accordance with the slightly convex ambulacral areas.

Order: IRREGULARES.

Suborder: GNATHOSTOMATA.

Family: *ECHINOCONIDÆ*.

Genus: ECHINOCONUS, Breyn.

ECHINOCONUS GIGAS, Cotteau. Pl. III. fig. 2-2A.

1856. *Echinoconus gigas*, Cotteau, Paléontologie française, Terrain Crét, p. 511; pl. 994, fig. 6, pl. 995.

Unfortunately only two specimens of this pretty species have been found, both of which are so much damaged that I am unable to give a full description; however they allow of the determination of the chief characters.

| <i>Dimensions.</i> | |
|--------------------|----------|
| Length | L=60 mm. |
| Breadth | b=55 „ |
| Height | h=50 m. |

} approximately.

The test is of a subpentagonal shape, a little broader anteriorly, than posteriorly, where it is visibly contracted. The upper surface is slightly inflated and equally rounded in all directions; profile line semicircular, apparently a little more steeply inclined forwards than backwards. Lower surface flat or slightly convex.

Apical disc slightly excentral towards the anterior margin.

Ambulacral areas narrowly lanceolate, extending from apex to the periproct; poriferous zones linear, slightly concave, composed of minute pores which are arranged in oblique pairs; each pair is separated from its neighbours by a low filiform ridge, and the two pores are again separated by a vertical septum joined to two horizontal ones; each pore opens on the top of a minute boss.

Peristome and periproct unknown.

The ornamentation consists of small perforate tubercles, sunk in deep and comparatively broad scrobicules, and very minute tubercles of the same kind arranged in circles round the former; both kinds are very homogeneous and not much crowded. On the interporiferous zone of the ambulacral area the tubercles are arranged in 6 or 7 rows, the two external ones of which are composed of smaller tubercles than the others, which are of the same size. On the interambulacral areas the tubercles are arranged in irregularly curved lines, in such a way that one row extends from the median suture to the poriferous zones over several plates.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Cotteau states that the chief specific features of *Echinoconus gigas* are its large size, its generally inflated test, particularly its conical transverse section. Now, if we apply this characteristic to the specimens from Baluchistán, it fits them

become so small that they are hardly visible. On the ambulacral areas there are six rows of them which are reduced to two near the mouth, whilst on the upper surface they are arranged in such a way that each plate carries one tubercle. On the interambulacral areas there are at least 14 rows of tubercles of the same kind, which are, however, reduced to two near the mouth, but continue to the apex, where they become very small.

Locality and stratigraphical position.—Dés Valley, horizon 4.

Remarks.—Owing to the thinness of the test, all the specimens are more or less damaged or crushed; this has, however, the advantage that the internal side of the test can be examined, which shows that no internal septa exist, and the specimen under examination really belongs to the genus *Holcotypus*, not to *Discoidea*; apart from this, the large size of the periproct, rather speaks for *Holcotypus* than for *Discoidea*.

This form is distinguished from all other known species by its ornamentation of the test.

Suborder: ATELOSTOMATA.

Family: CASSIDULIDÆ.

Subfamily: ECHINONEINÆ.

Genus: PYRINA, Desmoul.

PYRINA ATAXENSIS, Cotteau. Pl. III. fig. 4-4c, 4A., Pl. IV. fig. 1-1a, 2-2b, 3-3a, 4-4A, 5-5b.

1863. *Pyrina ataxensis*, Cotteau; Echinides fossiles des Pyrénées, pl. 42.

Dimensions of the different varieties.

| | Var. pentagonalis. | | | | Var. tumida. | | | | Var. globosa. | | | |
|---------|---------------------|-----|------|--------|--------------|-----|------|--------|---------------|-----|------|--------|
| | I. | II. | III. | IV. | I. | II. | III. | IV. | I. | II. | III. | IV. |
| Length | L = 29 | 24 | 24 | 23 mm. | 29 | 26 | 25 | 21 mm. | 31 | 25 | 24 | 16 mm. |
| Breadth | b = 27 | 22 | 22 | 22 „ | 25 | 23 | 22 | 18 „ | 28 | 24 | 22 | 14 „ |
| Height | h = 17 | 15 | 14 | 14 „ | 21 | 19 | 20 | 15 „ | 25 | 23 | 20 | 13 „ |
| | $\frac{b}{L} = .92$ | .91 | .91 | .96 | .85 | .88 | .88 | .86 | .90 | .96 | .91 | .90 |
| | $\frac{h}{L} = .60$ | .61 | .60 | .60 | .72 | .73 | .80 | .71 | .83 | .92 | .83 | .81 |

The shape of the test varies considerably as will be seen from the above figures; the larger number of specimens which have come under examination have a pentagonal shape, slightly enlarged before and slightly contracted behind; the upper surface is inflated, and the profile, forming half an ellipse, slopes equally in either direction; this variety might be called var. *pentagonalis*.

In the next variety, var. *tumida*, the pentagonal shape is still preserved, although not in such a marked way as in the former, the circumference having

become more rounded, but the upper surface is much more inflated, the test has become more globular, and the profile forms nearly a complete ellipse.

In the third variety, var. *globosa*, the pentagonal shape has almost disappeared and the test has become nearly circular; at the same time, the inflation of the upper surface has gone still further, the profile forming an ellipse nearly approaching a circle, the test thus becoming globular.

As may be expected from this description, the lower surface of var. *pentagonalis* is large, flat, and only slightly pulvinated near the circumference; in the var. *tumida* it is a little more inflated and in the var. *globosa* it is nearly as much inflated as the upper surface. Ambitus rounded in a varying degree.

Apical disc central, very small composed of five genital plates, four of which are perforated by large holes; the fifth imperforate, and five small ocular plates perforated by tiny holes; the two posterior ones nearly overlap the imperforate genital plate; madreporiform plate a little larger than the other genital plates.

Ambulacral areas narrowly lanceolate, extending from the apical disc to the mouth; the poriferous zones are linear, slightly concave; the pores are minute and placed in oblique pairs; in passing around the ambitus and on the lower surface the pairs arrange themselves in numbers of three, in oblique lines.

The peristome is out of the centre, just a little nearer to the anterior margin; it forms an irregular pentagon with its long axis obliquely directed from right to left. Periproct large, longitudinal and pyriform, just above the posterior margin but invisible from above; from below only its lower edge can be seen; in var. *pentagonalis* the periproct is hardly above the margin, while in var. *globosa* it seems to be right in the middle of the height of the test.

The ornamentation consists of small imperforate tubercles which are deeply sunk in a very narrow scrobicule; on the lower surface the tubercles are larger and more numerous than on the upper surface, where they are smaller and more sparingly distributed, with numerous delicate granules between them. On the interporiferous zone of the ambulacral area the tubercles show a tendency to arrange themselves into rows, of which there are eight altogether; the three outer ones are very regular, and their tubercles, increasing in size towards the interior, are arranged in alternating lines; the two inner rows are less regular. On the interambulacral areas the tubercles are irregularly distributed, but apparently they are more crowded towards the lower lines than in the interior.

Locality and stratigraphical position.—Dés Valley, horizons 2 and 4, very common; rare at Mazár Drik, horizon 8.

Remarks.—It might be more advisable to describe the above three varieties under three separate specific names, as they are seemingly well characterised by the differences in the shape of the test, than to unite them under one common name. I fully admit that if we take, say, fig. 1 of var. *pentagonalis* and fig. 5 of var. *globosa*, this view would be justified, provided we had only these two specimens and no intermediate links; but these two extremes are so intimately connected by imperceptibly varying links, that it is impossible to consider them as separate species when we have proof that they only form the terminal points of a continuous

chain. This will be more convincing if we compare the ratio height to length of some of the specimens. Arranged in ascending order, these figures are:

•60 •61 •68 •71 •72 •73 •80 •81 •83 •86 •92.

We have therefore at one end specimens where the height is barely $\cdot 6$ of the length, while at the other end there are forms where it reaches more than $\cdot 9$, yet both these extremes are connected by a series of intermediate forms which are sometimes difficult to classify. I have arranged them in such a way that var. *pentagonalis* includes all the forms of which the ratio is below $0\cdot 63$; var. *tumida* includes all those below $\cdot 80$ and var. *globosa* all those above $\cdot 80$.

The above arrangement seems to represent the three varieties very well, but if we sort a number of specimens, there will always be some specimens having a ratio .64 or .81, which it is difficult to include amongst the one or the other variety, between which they form the connecting links. However, such specimens must be expected and they only prove that, though there is a large difference between a specimen of the ratio .60 and one of the ratio .92, it is impossible to consider them different species.

The varieties as above described, may be referred to *Pyrina ataxensis*, Cotteau, although it seems that the species from Baluchistán become sometimes more pentagonal in plan and globular in shape than the specimens figured on plate 988 of the Paléontologie française; on the other hand, the var. *tumida* agrees so well in shape with Cotteau's species, that I have not hesitated to identify the Baluchistán forms with it.

PYRINA GIGANTEA, spec. nov. Pl. IV. fig. 6-6c.

Dimensions.

[illegible]

The test has a subpentagonal shape, being slightly broader anteriorly than posteriorly; the upper surface is highly inflated, conical; the profile is much more sharply curved on the anterior side, than on the posterior one, where it slopes more gently. The sides are rounded, the lower surface is slightly pulvinated, only around the peristome it is a little depressed.

The apical disc is small, slightly excentral in an anterior direction; the four genital plates are rather small and perforated by large holes, but the madreporic plate surpasses the others considerably in size and completely fills the centre. The ocular plates are minute and hardly visible.

The ambulacral areas are narrowly lanceolate, extending from the apical disc to the peristome; the poriferous zones are linear, very narrow, and slightly concave. The minute pores are equally rounded and arranged in oblique pairs, which on the

ambitus and lower surface form groups of three pairs, which are inclined in the apical direction.

The peristome is small, slightly excentral, and apparently irregularly pentagonal.

The periproct is large, pyriform, the point being turned in an apical direction, situated just above the margin in such a way that it can still be seen from below.

The ornamentation consists of small tubercles sunk in deep scrobicules, which are slightly larger, and more crowded on the lower, than on the upper surface; they are sometimes surrounded by minute granules. On the interporiferous zone the tubercles are arranged in 9 vertical rows, which, except the median one, reach from the mouth to the apical disc, and increase in size towards the centre line, the tubercles of each row alternating with the others; the tubercles are therefore also arranged in apically inclined lines; on the interambulacral areas the tubercles are very irregularly distributed, although there is a tendency to an arrangement in vertical rows.

Locality and stratigraphical position.—Dés valley, horizon 4.

Remarks.—By its larger size and the position of the periproct this species can be easily distinguished from *Pyrina ataxensis*, Cotteau.

Subfamily : ECHINOLAMPINÆ.

Genus : ECHINANTHUS Breyn.

ECHINANTHUS GRIESBACHI, spec. nov. Pl. IV. fig. 7-7A, 8-8b.
Pl. V. fig. 1-1A, 2-2b.

Dimensions of four specimens.

| | | | | | | | | | | | | | |
|---------|---------------|---|---|---|---|---|---|---|---|-----|-----|-----|-----|
| Length | L | . | . | . | . | . | . | . | = | 39 | 38 | 37 | 26 |
| Breadth | b | . | . | . | . | . | . | . | = | 32 | 32 | 28 | 22 |
| Height | h | . | . | . | . | . | . | . | = | 20 | 20 | 21 | 16 |
| | $\frac{b}{L}$ | . | . | . | . | . | . | . | = | .82 | .84 | .76 | .84 |
| | $\frac{h}{L}$ | . | . | . | . | . | . | . | = | .51 | .52 | .56 | .61 |

The moderately thick test is oval, but very slightly narrower in front than behind; the upper surface is tumid, varying considerably in the degree of elevation; in some specimens it is subdepressed, in others subglobular, as will be seen from the above figures for $\frac{h}{L}$; the apex generally coincides with the apical disc, but there are specimens where it is slightly behind it; the profile forms a regular semiellipse, but is very slightly truncated at the posterior end; the sides are rounded and more or less inflated; the lower surface nearly flat or very slightly convex.

The small apical disc is excentral and composed of four large genital plates perforated by large holes and five minute ocular plates.

The ambulacral areas, flush with the test, are narrowly lanceolate, limited to the upper surface, subpetaloid, and unequal in size; the single ambulacrum is short and broad, the antero-lateral pair broader and a little longer, the postero-lateral pair considerably narrower, but at the same time longer than the former. In the single ambulacrum the poriferous zones are slightly curved and consist of an equal number of pairs of pores; the inner pores are round, the outer elongated and conjugated to the former by a fine sulcus; on the narrow ridges between each pair of pores there is a row of 3 to 4 minute granules. In the antero-lateral ambulacra the poriferous zones are more strongly curved, the anterior zone being slightly shorter than the posterior one; in the postero-lateral pair the poriferous zones are only slightly curved, the posterior zone being narrower and considerably shorter than the anterior one. The pores are the same as in the single ambulacrum. At the lower end of the petals the pores become smaller, and are set wider apart as they pass round the border of the test to the peristome.

The peristome is subcentral slightly nearer to the anterior border, pentagonal, elongated in longitudinal direction and surrounded by a well developed floscelle.

The buccal petals are rather large, broad and nearly closed; their poriferous zones are well developed, but have not many pores, which are apparently of the same number in both rows. The posterior petals are shorter and broader than the anterior ones, which are the same length as the odd one.

The interambulacra end actinally in short rounded bourrelets which are covered on the sides with an exceedingly delicate granulation.

The longitudinal periproct is very small, pyriform, situated above the posterior border in such a way that it is neither visible from above nor below; the upper edge is slightly overhanging.

The ornamentation of the upper surface is very homogeneous and consists of numerous minute tubercles sunk in a deep scrobicule; on the lower surface the tubercles suddenly increase in size towards the centre, not covering, however, a rather broad band which extends from the posterior interambulacral bourrelet to the posterior border; in front of the mouth this band is short and not so well marked as behind; under the magnifying lens numerous delicate granules can be seen on this band.

Locality and stratigraphical position.—Dés Valley; horizons Nos. 2 and 4, Mazár Drik; horizon No. 8.

Remarks.—It will be seen from the above description that one of the peculiar features of this species is its lower surface; only in one specimen is it slightly concave in the centre; in all the others it is flat, even slightly convex. As regards the ornamentation of the lower surface it differs in this respect from all the other species known to me. The peculiar band extending from the posterior border to the mouth, and for a short distance beyond it, covered with minute tubercles, bordered on either side by areas covered with rather large tubercles sunk in deep scrobicules, increasing in size towards the centre, gives this species an appearance quite like a *Cassidulus*.

Genus : CLYPEOLAMPAS, Cotteau.

CLYPEOLAMPAS HELIOS, spec. nov. Pl. V. fig. 3-3b, 4, 5-5A.

Dimensions of three specimens.

| | | | | | | | | | | | |
|---------|---------------|---|---|---|---|---|---|---|------|-----|-----|
| Length | L | . | . | . | . | . | . | . | =61 | 58 | 56 |
| Breadth | b | . | . | . | . | . | . | . | =48 | 50 | 47 |
| Height | h | . | . | . | . | . | . | . | =42 | 40 | 37 |
| | $\frac{b}{L}$ | . | . | . | . | . | . | . | =.88 | .86 | .84 |
| | $\frac{h}{L}$ | . | . | . | . | . | . | . | =.68 | .68 | .66 |

The thick test is oval, slightly broader behind than before, where it is a little contracted; the upper surface is tumid; the apex excentral and slightly forward; the longitudinal profile declines in a short curve on the anterior side, while it slopes a little more on the posterior side; the sides are inflated and rounded; the lower surface flat, slightly concave around the mouth.

The excentral apical disc, which is star shaped, is composed of four genital plates which are perforated by large holes and five ocular plates perforated by minute holes; the genital plates are very small, with the exception of the madreporiform plate, which is very large and completely fills the centre, nearly overlapping the other plates; the ocular plates are microscopical and hardly visible.

The ambulacral areas flush with the test are broadly lanceolate, open, straight and very uniform in their proportions; the posterior ambulacra slightly longer than the others, the single ambulacrum and the anterior pair equidistant from each other, but the posterior pair is slightly more distant from the anterior pair and is placed more closely together. The number of pairs of pores in each zone is nearly equal, varying from 64 to 66; the pores in the inner row are small and round; the outer pores are elongated and are joined to the former by fine horizontal sutures. At the lower part of the petals the pores suddenly become much smaller and are set much wider apart as they pass round the border of the test and extend to the peristome, where they increase again in size. The peristome is slightly excentral and occupies a slight depression near the anterior border; it is rather large, pentagonal and surrounded by a large well developed floscelle.

The buccal petals are only slightly concave, but rather broad and widely open at their ends; the poriferous zones are well developed and consist of numerous small elongated pores in the outer row, and a smaller number of rounded pores in the inner row which are connected by very shallow grooves. The single petal is the shortest, the antero-lateral pair the longest.

The interambulacra end in short rounded bourrelets which are covered at the sides with an extremely delicate granulation and on the top with a few larger tubercles.

The small longitudinal periproct is situated just above the posterior margin, but not visible from above, at the lower end of two obtuse, hardly visible keels, which extend from the apical disc to the posterior margin.

The ornamentation of the upper surface consists of very small tubercles sunk in shallow scrobicules, between which there are numerous minute granules. On the lower surface the tubercles become much larger and the scrobicules are much wider, with the exception of a narrow longitudinal band that runs from the posterior interambulacral bourrelet to the periproct. The lower surface is entirely covered with the larger tubercles ; under a magnifying lens it will be seen that the apparently smooth band is covered with minute granules surrounded by scrobicules ; this feature, however, is only well seen on specimens which have not been much worn by weathering.

Locality and stratigraphical position.—Dés Valley; horizons Nos. 2 and 4, Mazár Drik, horizon No. 8.

Remarks.—*Clypeolampas helios* is so closely related to *Clypeolampas ovum* from the upper cretaceous strata of the Pyrenees that I first considered it identical with that species, but on closer examination I noticed the following differences (provided, of course, that the figure of that species in the *Paléontologie française* is correctly drawn): *Clypeolampas ovum* is broader on the anterior side and acuminate behind, while just the opposite features are exhibited in *Clypeolampas helios*, which is broader behind and contracted in front. The chief distinguishing feature is, however, the higher and more conical shape of the test: the ratio $\frac{h}{l}$ is 0·76 in *Clypeolampas ovum*, while it certainly does not exceed 0·68 in *Clypeolampas helios*.

Whether there really exists a longitudinal band on the lower surface covered with minute tubercles or not I am unable to say. If it is really absent in *Clypeolampas ovum*, it would form a good distinguishing feature from the Baluchistán species.

CLYPEOLAMPAS VISHNU, spec. nov. Pl. IV. fig. 1-1c.

| <i>Dimensions.</i> | | | | | | | | | |
|--------------------|---------------|---|---|---|---|---|---|---|---------|
| Length | L | . | . | . | . | . | . | . | =46 mm. |
| Breadth | b | . | . | . | . | . | . | . | =39 " |
| Height | h | . | . | . | . | . | . | . | =14 " |
| | $\frac{b}{L}$ | . | . | . | . | . | . | . | =84 |
| | $\frac{h}{L}$ | . | . | . | . | . | . | . | =30 |

Only a single specimen of this species has come under examination, and this has suffered to such an extent from weathering that all the finer details are effaced. The test is elliptical, a little narrower anteriorly than posteriorly; the upper surface is tumid and the apex is considerably excentral, being nearer the anterior margin; the profile forms, therefore, an unsymmetrical curve which slopes very gradually toward the posterior, and steeply towards the anterior margin; the sides are pretty steep, slightly inflated, the ambitus rounded, the lower surface is flat, even a little concave around the mouth.

Apical disc not visible.

Ambulacral areas lanceolate, open at the end, rather long and unequal in size,

the posterior pair being the longest, the odd one the shortest; poriferous zones straight, narrow, composed of small pores.

Mouth pentagonal, transversely elongated, surrounded by a large floscelle, the details of which are effaced.

Periproct supramarginal, rather large.

Ornamentation not visible.

Locality and stratigraphical position.—Mazár Drik, horizon 2a.

Remarks.—Although not well preserved, there is no doubt that this specimen belongs to the genus *Clypeolampas*. It is easily distinguished from *Clypeolampas helios*, by its low, rather depressed test, the ratio of height to length being very much smaller.

Family : *HOLASTERIDÆ*.

Subfamily : *ANANCHYTINÆ*.

Genus : *HEMIPNEUSTES*, Agassiz.

1847. *Hemipneustes*, Agassiz, Catalogue raisonné des esp., etc. d'Echinides, Annales des sciences naturelles, ser. iii, Zool., Vol. VIII, page 34.

Test suborbicular or elliptical, slightly truncated behind; upper surface high and inflated or low and depressed, lower surface flat or slightly convex.

Anteal sulcus extending from summit to mouth; broad and flat at the beginning, narrow and deep near the mouth.

Apical disc slightly elongated, composed of four genital plates perforated by large holes, and five smaller ocular plates perforated by minute holes; the right antero-lateral genital plate larger than the other, serves as madreporic plate.

Ambulacra open and unequal; the single one, lodged in the anteal sulcus, is composed of extremely fine narrow and equal poriferous zones; pores very small and obliquely arranged in pairs. Lateral ambulacra broad, flush with the test and composed of very unequal poriferous zones; anterior zone very narrow, pores very small, in horizontal pairs, posterior zone broad; pores of equal size, inner pores small and round, outer ones elongated and joined to the former by a narrow furrow. Basal portion of the postero-lateral ambulacra long, and marked by a few scattered pores; antero-lateral ones indistinct, short, and only indicated by a few pores at the anterior corners of the mouth.

Peristome near the anterior margin small and semilunar; posterior lip strongly developed and projecting. Anal opening just above the posterior margin, at the upper end of a depression which deeply grooves the posterior margin.

No fascioles.

Tubercles of two kinds; small homogeneous granules all over the surface; larger tubercles surrounded by a scrobicule on either side of the anteal sulcus on the upper surface, and in two regions, a lateral and a central one, separated by two smooth bands on the lower surface.

Remarks.—The genus *Hemipneustes* was founded by Agassiz in 1835 on two remarkable urchins, one of which was the well known *Spatangus radiatus*, Lam., from Maëstricht; the second was *H. africanus* from the upper cretaceous beds of Algiers. Agassiz characterises the new genus as follows:—

“Test élevé, très épais. Un sillon antérieur profond. Ambulacres pairs à fleur de test, zones porifères inégales; les extérieures ayant des pores allongés transversalement, les intérieurs de simples trous ronds. Anus au bord postérieur. Quatre pores génitaux séparés par une plaque intermédiaire. Point de trace de fascioles, ni péripetales, ni sous anal. Deux espèces de la formation crétacée.”

The above diagnosis has been slightly amended by Désor,¹ and I fully agree with that author that a genus thus characterised should be easily recognised. Notwithstanding this and although fully realising the remarkable feature of lateral ambulacra, Forbes² is of opinion that the genus *Hemipneustes* is identical with the genus *Toxaster*, but he apparently forgets, as Désor justly remarks, that the ambulacra of *Hemipneustes* are open and not petaloid, and that the apical disc is elongated.

With more apparent justification, d'Orbigny³ identifies *Hemipneustes* with *Holaster*, dwelling in detail on the characters which are common to both genera, but, as Désor remarks, “la profondeur du sillon antérieur, le contraste frappant entre les deux zones porifères d'un même ambulacre” are characters which are quite sufficient to justify the independence of the genus *Hemipneustes*.

Désor's view has been generally accepted, and I think that if the characters as given in the above description of the genus are accepted, the genus *Hemipneustes* forms so characteristic a group that even in badly preserved specimens its identity cannot be mistaken.

Up to the present date five species of *Hemipneustes* were known, to which must be added a new one, so that there are now six species altogether, viz.,—

| | | |
|-------|--|-------------------------------|
| 1778. | <i>Hemipneustes striato-radiatus</i> , | Leske. |
| 1848. | „ | <i>africanus</i> , Deshayes. |
| 1862. | „ | <i>delettrei</i> , Coquand. |
| 1863. | „ | <i>pyrenaicus</i> , Hébert. |
| „ | „ | <i>leymeriei</i> , Hébert. |
| 1897. | „ | <i>compressus</i> , Noetling. |

Although the shape of the test varies considerably among these six species they all exhibit the generic characters in such a marked and uniform way that in my opinion it is only the shape of the test to which we have to look for specific distinctions. For this purpose the following two tables will give some interesting information. The first table contains the ratio $b \div L$ (breadth divided by length) and the second the ratio $h \div L$ (height divided by length).

| | | | | | | | |
|----------------------|---|---|---|---|---|---|---------------|
| | | | | | | | $h \div L$. |
| <i>H. leymeriei</i> | . | . | . | . | . | . | = 0.95 — .98 |
| <i>H. compressus</i> | . | . | . | . | . | . | = 0.91 — .92. |

¹ Synopsis des Echinides fossiles, 1858, page 349.

² Geological Survey of the United Kingdom. British Organic remains, Decade IV, fig. 1, 1852.

³ Paléontologie française: Terr. cré. Echinoides irreg., page 72.

| | | | | | | $h \div L$. |
|----------------------------|---|---|---|---|---|---------------|
| <i>H. delectrei</i> | . | . | . | . | . | = 0·92. |
| <i>H. striato-radiatus</i> | . | . | . | . | . | = 0·91. |
| <i>H. africanus</i> | . | . | . | . | . | = 0·90. |
| <i>H. pyrenaicus</i> | . | . | . | . | . | = 0·83 — ·88. |

We see that in *H. leymeriei*, Héb., length and breadth are nearly equal, while there exists a considerable difference between the two measurements in *H. pyrenaicus*; the shape of the circumference of the different species varies therefore considerably, while, so far as my observations go, it is not even constant in individuals of the same species.

As regards the ratio $h \div L$ we have the following table:—

| | | | | | | $h \div L$. |
|----------------------------|---|---|---|---|---|--------------|
| <i>H. africanus</i> | . | . | . | . | . | ·90. |
| <i>H. striato-radiatus</i> | . | . | . | . | . | ·74. |
| <i>H. delectrei</i> | . | . | . | . | . | ·66. |
| <i>H. pyrenaicus</i> | . | . | . | . | . | ·64. |
| <i>H. leymeriei</i> | . | . | . | . | . | ·64. |
| <i>H. compressus</i> | . | . | . | . | . | ·59. |

We see, therefore, that the height of the various species fluctuates between considerable limits, so that the amplitude may vary much, though the circumference remains the same; for the latter the amplitude is ·10—·15, for the first ·31; in other words, there exist high conical forms in which the height is nearly equal to the length, and low depressed forms where the height is only slightly in excess of half the length. On the plate opposite I have depicted the outlines of the various known species of *Hemipneustes* which will convey a much better idea of the characteristic shape of each species than words can do.

If we now consider the geological position of the above six species, it will be seen that they all occur in the upper beds of the cretaceous system, the étage Danien of the French. This is of great importance as regards the development of the cretaceous system in Baluchistán, because we may justly infer that the same species which elsewhere characterise the étage Danien will be found in Baluchistán at the same horizon.

As regards the geographical distribution of the genus *Hemipneustes* we have here one of the strange and well nigh inexplicable instances of the distribution of animal life. According to various authors the hitherto known five species have been distributed as follows:—

1. *Hemipneustes striato-radiatus*, Lesk., Maëstricht, Dordogne(?)
2. „ *pyrenaicus*, Héb. } Pyrenees.
3. „ *leymeriei*, Héb. }
4. „ *africanus*, Cott. } Algiers (Prov. Constantine).
5. „ *delectrei*, Cott. }

And now we have in Baluchistán the following species:—

- Hemipneustes pyrenaicus*, Héb.
 „ *leymeriei*, Héb.
 „ *compressus*, spec. nov.

MEMORANDUM.

It is much regretted that the accompanying plate was omitted when issuing the paper by Dr. Fritz Noetling "On the Fauna of the Upper Cretaceous (Maestrichtien) Beds of the Mari Hills," published in the *Palaeontologia Indica*, Series XVI, Volume I, Part 3, Baluchistan Fossils. The plate should face page 28 of this paper.

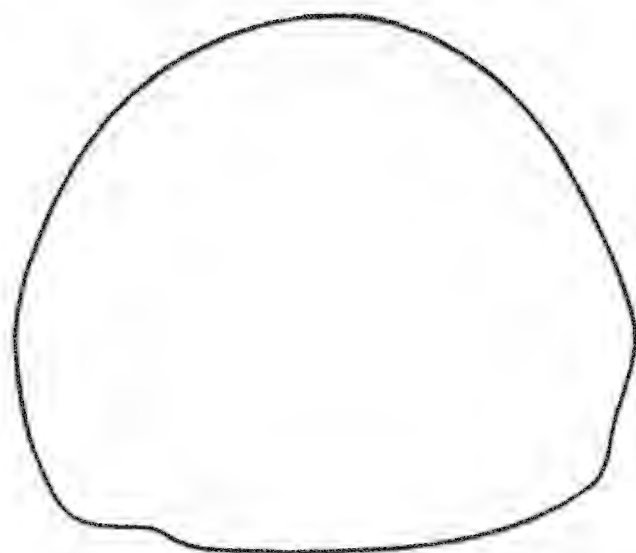
C. L. GRIESBACH,

Director, Geological Survey of India.

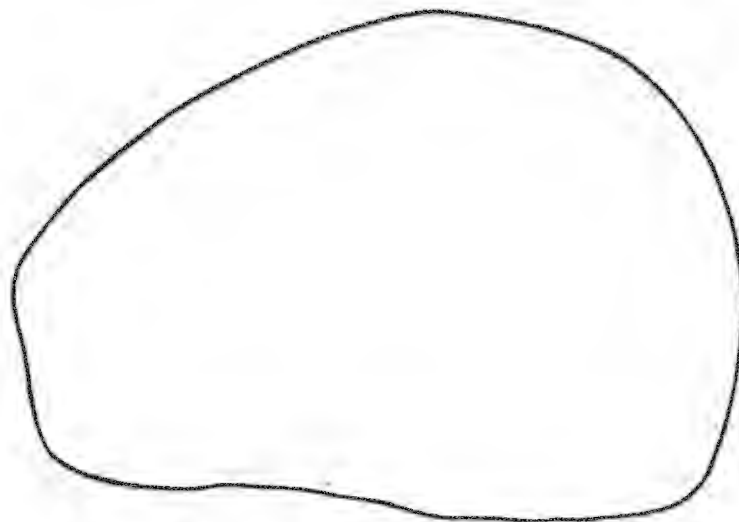
CALCUTTA,

15th July 1902.

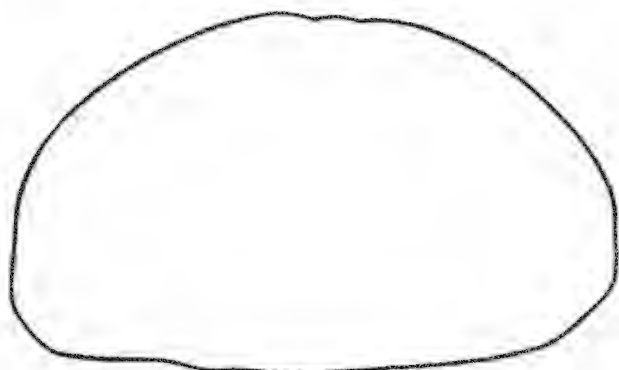
F. Noelling



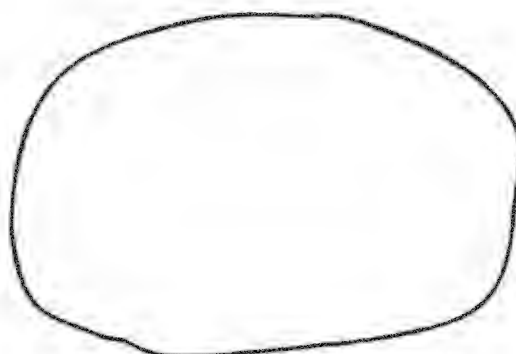
Hemipneustes africanus Boyle



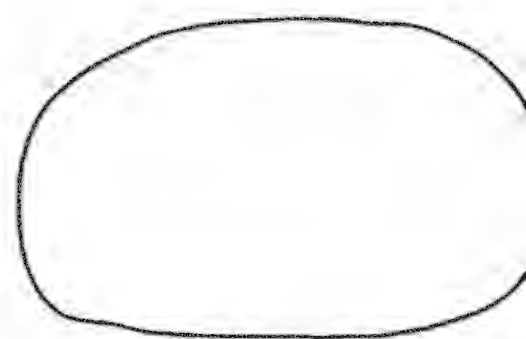
Hemipneustes striatello radiatus Leske



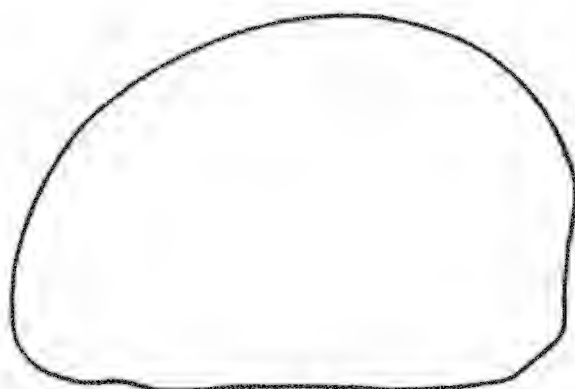
Hemipneustes delessii Esquimaud



Hemipneustes pyrenaicus Hebert
(Type from the pyrenees)



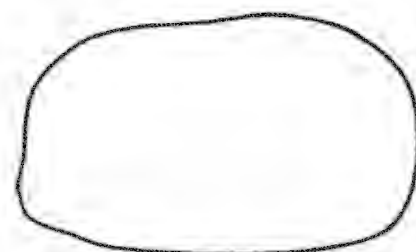
Hemipneustes pyrenaicus Hebert
(Baluchistan type)



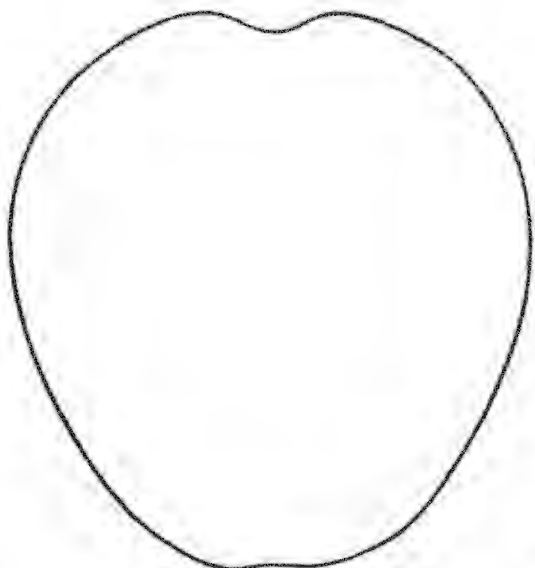
Hemipneustes leymeri Hebert
(Type from the pyrenees)



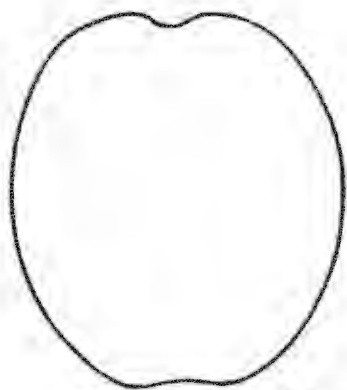
Hemipneustes leymeri Hebert
(Baluchistan type)



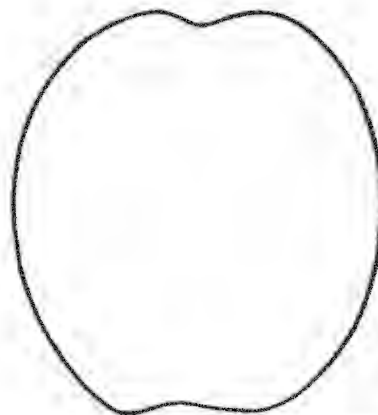
Hemipneustes compressus Noelling



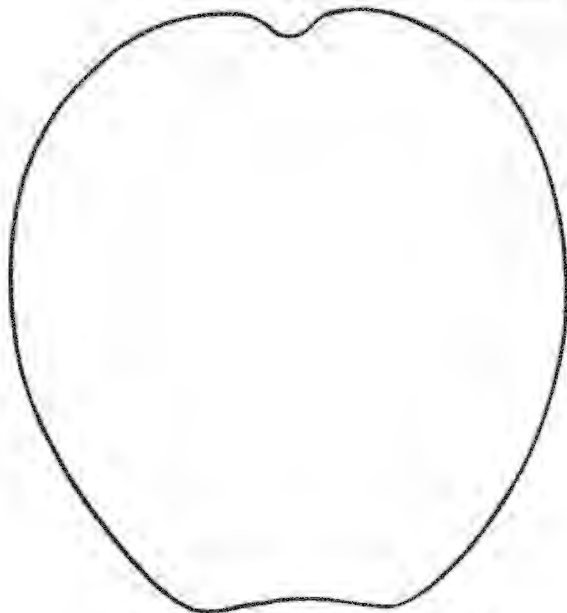
Hemipneustes leymeriei, Hebert
(Type from the Pyrenees)



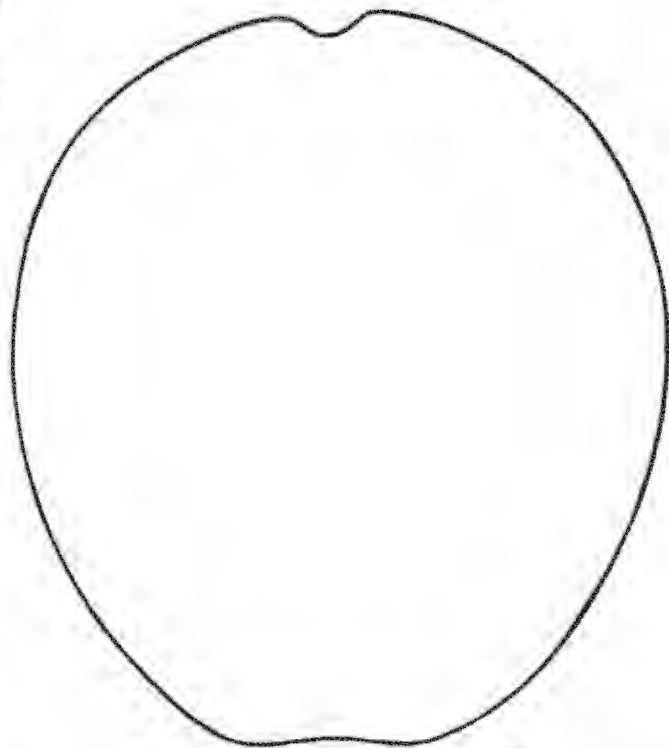
Hemipneustes leymeriei, Hebert
(Baluchistan type)



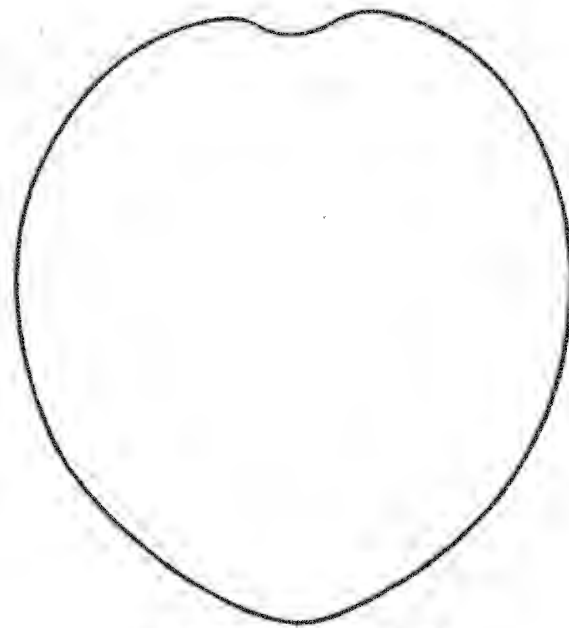
Hemipneustes compressus, Noellius



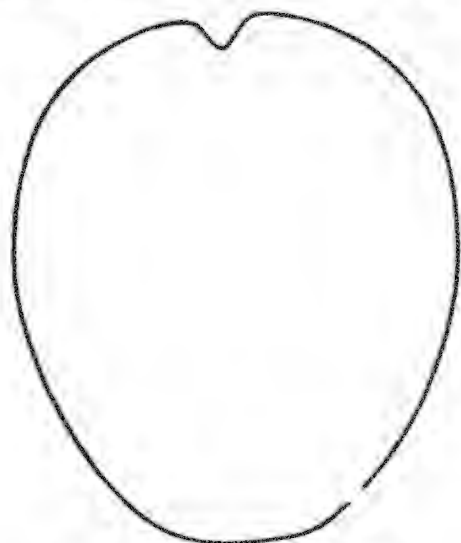
Hemipneustes deLollee, Coquand



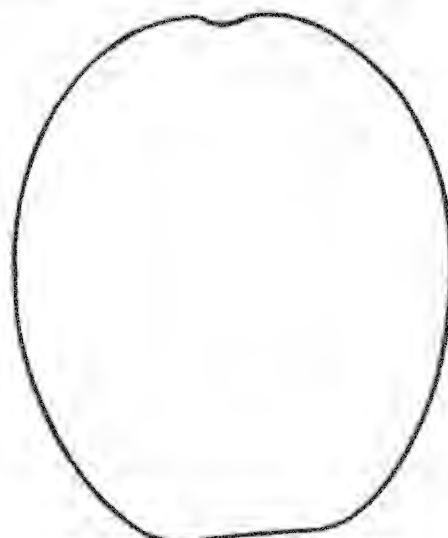
Hemipneustes striato-radialis, Leske



Hemipneustes africanus, Boyle



Hemipneustes pyrenaicus, Hebert
(Type from the Pyrenees)



Hemipneustes pyrenaicus, Hebert
(Baluchistan type)

It is certainly a most startling result that two species hitherto only known from the cretaceous deposits in the Pyrenees suddenly appear at a distance of thousands of miles in the cretaceous formation of Baluchistán. I expect many will receive this with the gravest doubts, and I may say that I hesitated for a long time before making such a surprising statement, but I can safely state that the force of the evidence was quite strong enough to convince me. I have particularly dwelt at length on the distinguishing features of the different species of *Hemipneustes* in order to enable every one to judge for himself whether my determination of the Baluchistán forms as *Hemipneustes pyrenaicus* and *leymeriei* is correct or not. I pointed out that the chief difference of the various species of *Hemipneustes* lies in the shape of the test, and as in this respect the forms from Baluchistán agree absolutely with those from the Pyrenees, I think that their identity is established beyond doubt.

Although a remarkable fact, there is no reason why European forms should not also occur in the cretaceous system of Baluchistán. The well known *Janira quadricostata* of Central Europe is very common in the same beds in which the *Hemipneustes* species have been found. The strange thing is that Pyrenean forms which do not occur in Algiers, reappear in Baluchistán. How this remarkable problem will eventually be solved is more than I can say at present.

Dr. Stoliczka¹ has described as *Cardiaster orientalis* an urchin which, in my opinion, is probably a *Hemipneustes*. I have examined Dr. Stoliczka's original, and was much surprised to find that the specimen fig. 2 to which the name *Cardiaster orientalis* was given, has not only lost its original shape entirely by deformation, but that little more than three quarters of the upper surface of the test is preserved at all. The whole of the lower surface, the ambitus, and a large part of the posterior side of the test are worn away. There remains, therefore, nothing but a part of the upper surface, which exhibits the ambulacra, of which the postero-lateral ones are only partly preserved. Now, if one may be allowed to judge from such an ill preserved specimen, I think the poriferous zones exhibit those features which are characteristic of *Hemipneustes*; the deep anteal sulcus would be quite in accordance with this view; the geological position also of this species—the Ariyalúr stage, the top beds of the cretaceous system of Southern India—would agree with this view. I refrain, however, from expressing a definite opinion, until some better preserved material comes to hand; but if I am right, then the genus *Hemipneustes* would extend as far as Southern India.²

HĒMIPNEUSTES PYRENAICUS, Hébert. Pl. VI. fig. 2-2b, 3-3A, 4-4a. Pl. VII. fig. 1-1a.

1875. *Hemipneustes pyrenaicus*, Hébert, Bull. de la Soc. Géol. de France, ser. iii, III, page 593, pl. XIX.

Dimensions of four specimens.

| | | | | | | |
|---------|----|-----|-----|-----|-----|-----|
| Length | L. | 68 | 65 | 62 | 59 | mm. |
| Breadth | b. | 57 | 55 | 54 | 52 | „ |
| Height | h. | 42 | 41 | 40 | 38 | „ |
| | b | | | | | |
| | L | ·83 | ·84 | ·87 | ·88 | |
| | h | | | | | |
| | L | ·62 | ·63 | ·64 | ·64 | |

¹ Palæontologia Indica: Cretac. Fauna of South India, Vol. IV, Part 3, page 22.

² I may mention here that Stoliczka's fig. 1 of *Cardiaster orientalis* is entirely different from fig. 2, and that I fail to see how both specimens can be considered as one and the same species.

The test is oval, imperceptibly truncated behind; the upper surface is elevated, but somewhat flattened in the middle; anteriorly it falls perpendicularly, while on the posterior side it slopes very slightly. The profile forms, therefore, a very characteristic curve which cannot be mistaken. The sides are perpendicular, the ambitus rounded, and the lower surface more or less convex.

The apical disc is nearly central and very slightly elongated; it is formed of four genital plates which are perforated by large holes; and of five small ocular plates which are perforated by very minute holes; the right antero-lateral genital plate, which is larger than the others, serves as madreporic plate.

The antecal sulcus is broad and flat near the summit, but quickly becomes narrow and very deep towards the ambitus; it is bordered by a rounded keel on each side.

The single ambulacrum, which is lodged in the antecal sulcus, is composed of extremely narrow and fine poriferous zones; the pores are small, obliquely arranged in pairs, which closely follow each other in the upper part, but become more and more distant towards the ambitus.

The antero-lateral ambulacra are large, rather long and slightly curved forwards; they are composed of two very unequal poriferous zones; the anterior one is extremely narrow towards the summit, but becomes a little wider at its lower end; the pores are very small, and arranged in horizontal pairs. The posterior zone is a little flexuous and very broad; the pores are of very unequal size; those of the inner row are small and round, those of the outer row elongated, and joined to the former ones by a long but narrow furrow. Each pair of pores is separated by a long but narrow ridge covered with one line of minute granules, which are easily worn away. Their basal portions are very indistinct and are only marked by a few pores each situated on a tubercle near the anterior corner of the mouth.

The postero-lateral ambulacra show the same arrangement of the poriferous zones, but they are a little shorter and less broad, while on the other hand they are somewhat more flexuous. Their basal portions are marked by two rather broad, apparently smooth, bands, which extend on either side of the plastron from the posterior border to the mouth. A few scattered pores are very distinctly seen near the corners of the mouth; they are more crowded and situated on a tubercle, which is surrounded by a deep scrobicule.

The peristome is situated near the anterior border in a depression formed by the deep grooving of the antecal sulcus; it is rather small, semilunar in shape, and possesses a strong upper lip.

The periproct is oval, rounded above, but pointed below, with its longest diameter in perpendicular direction; it is situated at the upper end of a groove which deeply indents the posterior border.

The tubercles are numerous and of two kinds; the whole of the upper surface except the two edges of the antecal sulcus is covered with homogeneous fine granules; on the base and on the edges of the antecal sulcus the tubercles are considerably larger and surrounded by a scrobicule which is particularly well marked, like those on the edges of the antecal sulcus; very fine granules are densely distributed between the

larger tubercles, but on the base they are sometimes arranged in scrobicular circles. The course of the basal portions of the postero-lateral ambulacra divides the base into a central and a lateral region, which show a marked difference in the size of the tubercles; on the plastron they are not only generally smaller than on the lateral region, but they also decrease in size from the edges towards the centre of the broad band which extends from the mouth to the posterior border. The lateral region forms a moderately broad band along the circumference, and the tubercles decrease in size from the inner edge towards the periphery; it must be particularly noted that they do not extend above the ambitus. Between these two regions only very minute granules occur, which easily wear off; a few tubercles of larger size are also seen around the periproct.

Locality and stratigraphical position.—Upper cretaceous strata of the Pyrenees very common in the Dés Valley; horizon No. 2, Dés Valley; horizon No. 4, Mazár Drik, horizon No. 8, (rare).

Remarks.—Although it may seem hazardous to consider a species occurring in the cretaceous strata of Baluchistán identical with one which is found in the Pyrenees, I think that my views will stand even the most rigorous examination. The most striking coincidence will be found as regards the shape of the test. Hébert gives the following proportional figures of *H. pyrenaicus*:—

$$\begin{array}{rcl} \frac{b}{L} & = & \cdot 84 \quad \cdot 81 \quad \cdot 84 \\ \frac{h}{L} & = & \cdot 61 \quad \cdot 638 \quad \cdot 634 \end{array}$$

Now, if these figures are compared with the ratios as given for the Baluchistán form, it must be admitted that they are nearly exactly the same, and I have no doubt that every one will agree with me that differences of $\cdot 07$ may be considered as immaterial.

Now, if we compare the profile of the two forms, we notice exactly the same curve of the upper surface: nearly flat in the middle, dropping vertically on the anterior sides, while it slopes just perceptibly posteriorly; the lower surface is convex, while the sides are nearly perpendicularly inclined; the test has therefore a barrel shape which forms the most characteristic feature of this species.

The only differences which I can discover exist with regard to the distribution of the larger tubercles on the lower surface, and the position of the anal opening. If Hébert's figure is absolutely correct, the larger tubercles cover also the posterior part of the smooth bands which represent the basal portion of the postero-lateral ambulacra; on the other hand, the difference of size in the tubercles of the plastron are distinctly visible in Hébert's figure, although it is obvious that the tubercles are somewhat diagrammatical.

As regards the position of the anal opening, it seems a little higher above the posterior border in Hébert's fig. 4, than it is in the Baluchistán specimens. I am,

expands at the lower end. The posterior zone becomes very quickly broad, but gets narrower towards the end; the pores are of very unequal size and show a remarkable arrangement, inasmuch as the outer pores are placed obliquely with regard to the inner ones; the narrow furrow by which they are joined forms therefore an obtuse angle with its apex turned upwards. Their basal portion is very distinctly marked, at the two anterior corners of the mouth, by a series of rather strong tubercles surrounded by deep scrobicules which are perforated on the top.

The postero-lateral ambulacra exhibit the same arrangement of the poriferous zones, but they are much shorter; their basal course is marked by two broad and apparently smooth bands on the lower surface, which show a few isolated pores; near the mouth the pores are arranged in a similar way to those of the antero-lateral ambulacra.

The peristome is very close to the anterior border, but unquestionably larger than that of *H. pyrenaicus*.

Situation of anal opening unknown.

Tubercles the same as in the previous two species, showing the same arrangements,—viz., the larger ones chiefly on the lower surface in two areas divided by two, apparently smooth, bands, and two series of the same kind, on either side of the anteal sulcus; but whether the tubercles are really smaller than in the two preceding species or not, I am unable to say.

Locality and stratigraphical position.—Very rare in the Dunghán stage of Mr. Oldham, Dés Valley.

Remarks.—I identified this species with reluctance with Hébert's *Hemipneustes leymeriei*, but after a careful examination I came to the conclusion, that it would be impossible to look upon the Baluchistán specimen as a different species, although it is apparently much smaller than Hébert's specimen. On the other hand, if we consider the shape of the test, particularly the profile of the upper surface, the likeness is striking; among all the known species of *Hemipneustes*, it is only *H. leymeriei* that has the apex situated behind the centre.

Besides the general shape there is the less marked anteal sulcus, but particularly the curious arrangement of the pores in the posterior zones of the lateral ambulacra. Hébert states that only the pores of the posterior ambulacra diverge, a feature, however, which is not well seen in his figure; the specimen which I examined shows that the anterior ambulacra also exhibit this feature, and, strange to say, the right antero-lateral ambulacrum in a much more marked way than the left one. As the specimen shows distinct signs of weathering, I am not quite certain whether this feature is not perhaps a secondary one, being the result of a partial superficial destruction of the plates of the poriferous zones.

H. leymeriei for another reason is one of the most remarkable species of this genus, for although all the other forms show a considerable difference between length and breadth, the measurements of both are nearly the same with this species; the ratio $\frac{b}{l}$ is .95 to .98 in the specimens from the Pyrenees and .98 in the Baluchistán specimen.

HEMIPNEUSTES COMPRESSUS, spec. nov. Pl. VII. fig. 3-3c, 4, Pl. VIII. fig. 1-1a, 2-2b.

| | | Dimensions of three specimens. | | |
|---------|---------------|--------------------------------|-----|----|
| Length | L | | =66 | 54 |
| Breadth | b | | =60 | 50 |
| Height | h | | =38 | 32 |
| | $\frac{b}{L}$ | | =91 | 92 |
| | $\frac{h}{L}$ | | =57 | 59 |

The test is suborbicular, there being little difference between breadth and length; the upper surface is elevated, but flattened in the middle; at either end as well as at the sides it falls off vertically, lower surface nearly flat or only slightly convex on the plastron. The test has therefore a vertically compressed appearance and the profile line in either direction resembles a rectangle with rounded corners. Ambitus rounded.

Apical disc nearly central, slightly advanced, and only slightly elongated; it is formed of four genital plates of nearly the same size, perforated by large round holes, and five smaller ocular plates which are perforated by minute holes; madre-pore plate slightly larger than the other genital plates.

The anteal sulcus is hardly perceptible on the upper surface, where it is indicated by a shallow depression only, bordered by two lines of strong tubercles; but it rapidly deepens on the anterior side, while it becomes rather narrow towards the mouth. Ambulacra exactly like those of *H. pyrenaicus*, but apparently the postero-lateral ambulacra meet at a less acute angle than with *H. pyrenaicus*.

Peristome and anal opening like those of *H. pyrenaicus*, but, owing to the more depressed shape of the test, the anal opening is perceptibly nearer to the posterior border.

Tubercles exactly the same as those of *H. pyrenaicus*; on the lower surface the tubercles in the centre of the plastron are apparently finer than in *H. pyrenaicus*; basal portion of the postero-lateral ambulacra covered with fine, minute granules.

Locality and stratigraphical position.—Together with *Hemipneustes pyrenaicus*, but apparently rarer than that species in horizon Nos. 2 and 4, Dés valley and No. 8, Mazár Drik.

Remarks.—I hesitated for a long time in separating this species from *H. pyrenaicus*, because it seemed to me only a variety of this form: but having a considerable number of specimens under examination, which all exhibited the same characters, I think I am justified in describing them under a new name. The chief feature, if not the only difference between the two species, rests in the different shape of the test; for while *H. pyrenaicus* has a pronounced elliptical shape, *H. compressus* is nearly orbicular, the greatest breadth being almost the same as the greatest length. *H. compressus* in this respect follows closely *H. Leymeriei*; on the other hand the vertically compressed shape of the test distinguishes *H. compressus* easily from the more inflated *H. pyrenaicus*; in fact as regards this feature *H. compressus* is the lowest known species of this genus and contrasts strangely with such forms as *H. africanus* or *H. radiatus*.

Taking all things into consideration *H. compressus* although very closely related to *H. pyrenaicus* may be easily distinguished in well preserved specimens; but if these are deformed or crushed in the smallest degree, the determination becomes nearly impossible, since other features, as the shallower anteal sulcus or the position of the anal opening, are in this case also affected and deformed.

Family: SPATANGIDÆ.

Subfamily: SPATANGINÆ.

Genus: HEMIASTER, Desor.

HEMIASTER BLANFORDI, spec. nov. Pl. VIII. fig. 3-3a.

| Dimensions. | | | | | | | | | |
|-------------|---------------|---|---|---|---|---|---|------|---------|
| Length | L | . | . | . | . | . | . | =27 | 27 25 |
| Breadth | b | . | . | . | . | . | . | =25 | 25 22 |
| Height | h | . | . | . | . | . | . | =22 | 21 19 |
| | $\frac{b}{L}$ | . | . | . | . | . | . | =·92 | ·92 ·88 |
| | $\frac{h}{L}$ | . | . | . | . | . | . | =·81 | ·78 ·76 |

The rather small globular test is subelliptical in shape, just a little longer than it is broad; posteriorly it is only slightly alluminate; the posterior side a little truncated; upper surface highly inflated; lower surface tumid, a little flattened anteriorly; ambitus rounded; highest point of the upper surface in the posterior inter-ambulacrum just above the periproct; from there the profile line drops nearly perpendicularly in a posterior direction, while forwards it slopes a little more gently till about the end of the single ambulacrum, when it also drops quite suddenly in a perpendicular direction.

Apical disc central, small and compact; four genital plates perforated by large holes. The anteal sulcus is moderately broad and deep on the upper surface, but it becomes narrow and very shallow at the ambitus, thus hardly indenting the anterior margin.

The single ambulacrum which is lodged in the anteal sulcus, is moderately long and open at the end; the poriferous zones are narrow and composed of minute pores arranged in oblique pairs. The grooves for the antero-lateral ambulacra are somewhat shorter, moderately deep, and rather broad at the end, continuing in the shape of narrow and shallow depressions towards the ambitus. The poriferous zones are broader than the inter-poriferous ones and composed of rounded conjugate pores which are arranged in horizontal pairs. The postero-lateral ambulacra are very short, and lodged in rather shallow grooves, the continuations of which also form narrow and shallow depressions as far as the ambitus. The inter-ambulacral areas are slightly swollen, the posterior one rising as a rounded keel. The periproct is vertically elliptical, and situated at the upper end of the truncated posterior side.

The peristome is transversely elliptical; the lower lip projecting. The fasciole is well developed and peripetalous, rather narrow, and crowded with rows of fine granules.

The ornamentation is rather peculiar and gives the test a corroded appearance; it consists of small tubercles sunk into deep and wide scrobicules, which are surrounded by a smooth rim; as the tubercles are very closely set, the rim of each is pressed by the surrounding ones into a subhexagonal shape. On the upper surface the tubercles above the fasciole are much smaller than below it, where they increase in size towards the ambitus. On the lower surface they are largest on the lateral interambulacral areas; on the plastron they are a little smaller, and increase in size radially from the blunt plastron point, which is covered with minute tubercles only; the ambulacral areas are set with much smaller tubercles.

Locality and stratigraphical position.—Upper cretaceous series, horizon 4, Dés valley.

Remarks.—The nearest relation to this species is *Hemiasper punctatus*, d'Orb., from the upper cretaceous series of the Pyrenees. But the chief distinguishing features of *Hemiasper blanfordi* are its more inflated test, and its peculiar ornamentation, the tubercles being much more closely set, and pressing on each other, thus deforming the circular shape of the scrobicules.

HEMIASPER OLDHAMI, spec. nov. Pl. VIII. fig. 4-4d, 5-5A, 6, 7.

Not one of the specimens is sufficiently well preserved to allow accurate measurements being taken; the thin test is of moderate size, the largest specimen being about 35 mm. in length; it is certainly longer than broad, and broader than high; its shape is broadly cordiform, being broader in front than behind, where it is acuminate; posterior margin slightly truncated. Upper surface not very much inflated, slightly depressed; lower flat; ambitus rounded. Unfortunately no exact view of the profile line can be obtained, but it seems that it slopes backwards and forwards rather rapidly with the same inclination. The apical disc is slightly behind the centre, apparently very small, not well seen in any of the specimens.

The anteal sulcus is rather deep on the upper surface, but gradually becomes shallow at the ambitus, so that it hardly indents the anterior margin.

The single ambulacrum lodged in the anteal sulcus is rather short and not closed at the end; the poriferous zones are very narrow, and are composed of small holes arranged in oblique pairs.

The antero-lateral ambulacra, in deep, rather broad grooves, are tolerably long and form an angle of about 135° ; they are slightly sinuous and nearly closed at the end. The rather broad poriferous zones are composed of elongated, slit-like pores which are arranged in horizontal, non-conjugate pairs; the ridge separating two pairs is lined with a row of minute granules. The interporiferous zone is considerably less broad than the poriferous zones. The postero-lateral ambulacra which are considerably shorter than the others, diverge at an angle of about 45° ; they are also lodged

in grooves which are narrow and deep near the apex, but quickly widen out and flatten near the lower end.

The interambulacral areas are swollen, very narrow near the apex, where the antero-lateral ones form a sort of short keel, which quickly expands; the posterior interambulacral area is very narrow, and was apparently raised into a low keel.

The periproct is apparently elliptical, and situated on the truncated posterior side, rather high above the border. Peristome unknown.

The fasciole is well developed and peripetalous; it is rather narrow and marked with many rows of minute granules; it is not very much curved, and round the petals is slightly bent in apical direction on the interambulacral areas.

The ornamentation consists of small tubercles with low non-perforate mamellons which are surrounded by a scrobicular circle of minute granules; on the upper surface, above the fasciole, the tubercles are rather sparsely distributed; below the fasciole they become more crowded and particularly on the anterior interambulacral areas, where they are also much larger; on the lower surface they are again very sparsely distributed, chiefly near the margin and on the plastron, leaving two smooth bands; the lower portions of the postero-lateral ambulacra are perfectly free.

Locality and stratigraphical position.—Upper cretaceous series, horizon 4, Dés valley.

Remarks.—*Hemiaster indicus*, Stol., which has some similiarity with the species described here, is easily distinguished by a shorter test, having a highly inflated upper surface and a broadly truncated posterior side; the profile line is therefore quite different in both species. *Hemiaster siva* is easily distinguished, not only by its general shape, but chiefly by the different ornamentation and the conjugated pores of the latero-ambulacral areas.

III. PELECYPODA.

1. Order : ANISOMYARIA.

1. Family : OSTREIDÆ, Lam.

Genus : OSTREA, Linné.

OSTREA ACUTIROSTRIS, Nilsson. Pl. IX., fig. 1-1b, 9-9a.

(Synonymy in Coquand, Monographie du genre Ostrea, p. 75.)

The shell, which attains a moderate size, is irregularly oval in shape, higher than long, rather compressed and not strikingly inequivalve. The left valve is moderately inflated, slightly sloping in anterior, posterior and ventral directions. The umbo is short, but very pointed and slightly turned backwards. Ligamental pit rather short and narrow. The surface is usually more or less foliaceous, owing to strong striæ of growth, but sometimes, particularly in the central part of the valve, there appear

irregular rounded radiating ribs, which are only very faintly expressed. The right valve is flat, the beak very short and pointed. Surface smooth, except some very strong irregular striæ of growth which make the surface appear somewhat rugose.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—By their general shape and compressed valves, exhibiting a very pointed umbo, the Baluchistán specimens are proved to belong to this well known species. According to Coquand this form characterises the étage Santonien, but it appears from his list of places where it has been found, that it probably ascends to a higher horizon.

OSTREA (ALECTRYONIA) PECTINATA, Lamarck. Pl. IX. fig. 2, 3-3a.

(Synonymy in Coquand, Monographie du genre Ostrea, p. 76.)

None of the specimens which have come under examination show a perfectly preserved shell, but still it may be seen that they belong to a narrow form which was moderately curved backwards, and which must have attained a considerable size and thickness. The ornamentation of the valves consists in very strong rounded ribs, which from being simple in the middle bifurcate at the sides. The posterior margin is very thick and nearly perpendicular, the anterior margin somewhat sloping.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—This species is one of the most characteristic fossils of the upper cretaceous strata, and, as far as known, chiefly characterises the étage Santonien. In Southern India it has been found in the Ariyalúr group.

OSTREA (ALECTRYONIA) UNGULATA, Schlotheim sp. Pl. IX. fig. 4-4b, 5.

(Synonymy in Coquand, Monographie du genre Ostrea, p. 58.)

The shell is sigmoid, very narrow, and somewhat compressed at both ends. It attains its greatest thickness at the anterior margin, and the surface of both valves slopes from there posteriorly. The anterior side is therefore high and thick, the posterior side low and sharpened. Both valves show the same ornamentation, which consists of short single ribs, lining the anterior and posterior margin, but not extending towards the central part of the shell, which remains smooth: this smooth medial space is one of the chief features of the species. On the anterior margin the interstices between two ribs take the form of long sharp teeth which deeply notch the ribs of the opposite valve. On the posterior margin the ribs are somewhat longer, particularly on the expanded area just below the beaks, where they are slightly curved, thin and sharp.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Stoliczka aptly remarks that this species characterises the upper cretaceous beds of almost all parts of the world. We may now add Baluchistán to the countries which Stoliczka enumerates.

2. Genus: GRYPHÆA, Lamarck.

GRYPHÆA VESICULARIS, Lamarck. Pl. X. 1-1a, 2-2b.

(Synonymy in D'Orbigny, Paléont. franc. Terr. Crét., Vol. III, p. 742.)

The inequivalve shell attains a considerable size up to 112 mm. in height, but in its general shape varies considerably. The left valve is irregular in shape; sometimes it is rather narrow at the umbonal part and gradually expands towards the ventral margin; other specimens are nearly as broad at the umbonal region, as they are at the ventral margin; it is, however, always highly inflated and very thick, particularly in the umbonal region. The umbo is low and depressed, the ligamental pit deep, broad, and transversely striated. The surface is smooth but more or less foliaceous through the irregular striæ of growth.

The right valve is more or less circular, flat, or even somewhat concave, much thinner than the left valve, and strongly bevelled all round, except on the hinge margin; ligamental pit short and triangular; surface very foliaceous; whether some radiating striæ on one of the specimens are only an accidental feature or not, cannot be decided.

Locality and stratigraphical position.—Mazâr Drik, horizon 8.

Remarks.—The form here described has the greatest similarity with *Gryphæa pina*, Leymerie,¹ and this author when creating the species states that it has the greatest likeness to *Ostrea (Gryphæa) vesicularis*, Lam., and it is chiefly on account of its stratigraphical position, which according to him is always lower than that of *Gryphæa vesicularis*, that he considers it useful to distinguish it from the latter species. It seems that its chief features are its considerable size, and its enormous thickness.

With regard to the latter features the specimens from Baluchistán agree very well with Leymerie's species, but there are other and in my opinion more important features which seem to point to a close relationship of both species. Leymerie's figures are compressed; for instance, with figure 1a it will be seen that the general outline of the left valves agrees exceedingly well; the wing-like expansion of the posterior side is particularly well developed in both specimens; there is further the same thick, rounded, depressed, but not incurved umbo in both species, and the features of the hinge are exactly the same; a broad ligamental pit, bordered by two broad ridges, both transversely striated, flanked on either side by a foliaceous area more or less triangular,—all these are features which the specimens from Baluchistán have in common with *Ostrea lissa*, Ley. On the other hand, I do not think that, to judge from the general shape of the shell, the Baluchistán specimens should be separated from *Gryphæa vesicularis*. Whether *Gryphæa pina*, Ley., is really an independent species or not, would, in my opinion, require further examination.

¹ Deser. Géol. et Pal. des Pyrénées, pl. I, fig. 1, a., b.

Genus: EXOXYRA, Say.

EXOXYRA PYRENAICA, Leymerie. Pl. IX. fig. 6-6b.

1851. *Exogyra pyrenaica*, Leymerie, Sur un nouv. type pyren. Mém. de la Soc. Géolog. de France, 2nd Ser., Vol. IV, p. 194, pl. B, 4, 5, 6.

The only specimen which has come under examination is of moderate size, being not more than 45 mm. high. The shell is elongated, narrow, and slightly curved in posterior direction. The left valve is ventricose, but somewhat depressed at the back and the ventral margin. A strong rounded keel, from which the surface slopes nearly perpendicularly in an anterior and more moderately in the posterior direction, runs down the centre of the valve, beginning at the umbo, but becoming slightly effaced towards the ventral margin. Beak depressed and strongly reversed. Surface smooth, except some irregular folds due to the growth of the shell.

Right valve much smaller, oval and flat. A similar keel runs from the beak in the axis of the valve, in front of which the surface slopes very steeply; behind it the slope is very moderate and the valve becomes even slightly concave. Umbo very small, depressed and reversed. The anterior part, which is more or less foliaceous, through numerous striæ of growth, shows numerous fine but somewhat irregular transverse striæ, which to a smaller extent are also visible on the posterior side.

Locality and stratigraphical position.—Mazár Drik.

Remarks.—The specimen above described shows such complete accordance in all essential features with the abovenamed species, that its identity with it is beyond a doubt. If, for instance, Leymerie's figure 4 is compared with the specimen from Baluchistán, it will be seen that the similarity between the two figures is surprising.

This species seems to have a wide distribution, having been first discovered in the upper cretaceous strata of the Pyrenees; it was subsequently noticed by d'Archiac¹ in upper cretaceous strata of Asia Minor, and now it has been found in Baluchistán in the same horizon.

2. Family: SPONDYLIDÆ.

Genus: SPONDYLUS, Linné.

SPONDYLUS SANTONIENSIS, d'Orbigny. Pl. XI. fig. 2.

1846. *Spondylus santoniensis*, d'Orbigny, Paléon. Franc., Terr. Crét., Vol. III, p. 666, pl. 457.

A large shell, unfortunately much damaged, may probably be identified with this species. The ornamentation of both valves consists of numerous, moderately strong, radiating ribs, some of which apparently carry large scaly spines, while the intermediate ribs were only foliaceous.

¹ Bullet. de la Soc. Géol. de France, 2nd Ser., Vol. XVI, p. 875.

Locality and stratigraphical position.—Dés valley, horizon 8.

Remarks.—Although the only specimen which has come under examination is much damaged, partly by weathering and partly through crushing, I have not the slightest doubt that it represents a *Spondylus*. As a considerable part of the substance of the shell is still preserved, its ornamentation, as above described, can be made out with some accuracy. The only species which has an ornamentation of the shell answering to the above description, is *Spondylus santoniensis*, d'Orbigny, to which species I have therefore referred the specimens from Baluchistán.

SPONDYLUS, spec. indet. Pl. XI. fig. 4-4a.

Besides the specimen above described, there is an ill preserved cast, which though belonging to the same genus, certainly represents another species. The shell was apparently of smaller size than that of *Spondylus santoniensis*, and the ornamentation of the left valve consisted of numerous filiform, somewhat irregular radiating ribs, separated by interstices of their own breadth and crossed by some strongly marked concentric striæ of growth. Whether the ornamentation of the right valve was the same cannot be ascertained; there were undoubtedly fine radiating ribs, but it is impossible to say at present whether there existed also stronger spines or not.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—It is to be regretted that this specimen is not better preserved, because it seems to bear the strongest resemblance to *Spondylus filusus*, Ley. This form, however, differs by the strength of the ribs, which are much broader than those of the Baluchistán form. The interstices are of smaller breadth than the ribs in *Spondylus filusus*, while they are of the same breadth, or even a little broader than the ribs in the above species. Leymerie's original is apparently not well preserved either, and it is quite possible that the two forms are identical; at any rate they bear a strong relationship to each other.

3. Family: PECTINIDÆ.

1. Genus: HINNITES, Defran.

HINNITES (?) FOLIACEUS, spec. nov. Pl. IX. fig. 7, 8.

The shell is irregularly circular, slightly inequilateral, and inequivalve. The beaks are very small, depressed, and hardly extend above the cardinal margin. The right (?) valve is only slightly inflated, nearly flat; the left (?) valve is flat, even somewhat concave. The ornamentation is apparently the same on both valves; it consists of numerous, closely set, fine, irregular radiating ribs, which are crossed by numerous more or less strong concentric striæ of growth, in such a way that the

continuity of the ribs is interrupted by them, and single parts of the radiating rib are raised into short foliaceous spines.

Locality and stratigraphical position.—Mazár Drik, horizon 8; Beji valley.

Remarks.—It is with hesitation that I include the above species among the genus *Hinnites*, because it seems that neither valve was provided with ears. It is unfortunate that none of the specimens exhibits the inner side of the valves, since its characters, particularly those of the hinge, would have been of particular value in reference to the generic position of this species. In fact, it is quite possible, to judge from the irregularly bent valves and the apparent absence of ears, that this species should be included among the family *Piacunidae* instead of *Pectinidae*.

2. Genus: VOLA, Klein.

VOLA QUINQUEANGULARIS, spec. nov. Pl. X. fig. 3-3a, 4-4a.

The shell attained only a small size apparently, as none of the specimens exceed 26 mm. in height. The right valve is triangular in shape, somewhat higher than long, and strongly inflated; the umbo is short, pointed, and somewhat incurved. The ornamentation consists of five strong, high, and moderately rounded radiating ribs, of which the central one is usually stronger than the lateral ones, which are separated by broad, somewhat concave, interstices. The whole surface is also covered with numerous, regular, fine radiating ribs, which seem to be composed of a broader central and two fine filiform lateral parts. The radiating ribs are crossed by very closely set, fine, undulating concentric striæ, which are easily worn off by weathering. The ears are small and were apparently unequal, the anterior one being the larger. The left valve is very imperfectly known, but it is apparently slightly concave, exhibiting a similar shape to the right valve.

Locality and stratigraphical position.—Dés valley.

Remarks.—This species is so closely related owing to its general shape and ornamentation to *Vola* (*Janira*) *sexangularis*, d'Orb., that it is only distinguished by the smaller number (5) of principal ribs.

VOLA QUADRICOSTATA, Sowerby sp. Pl. XI. fig. 5, 6-6b, 7-7b.

1814. *Pecten quadricostatus*, Sowerby, Min. Con., Vol. I, p. 121, pl. 56, figs. 1 and 2.

It would be superfluous to describe this well known species in detail; but a few remarks as to the peculiar features of the ornamentation will not be out of place. The difference in strength between the principal and intermediate ribs becomes in some specimens somewhat effaced, particularly when the left valve has attained some size, but at the same time the principal ribs remain always distinguishable. The number of intermediate ribs on the left valve is invariably three; there is not a single specimen which shows any deviation from that number.

Stoliczka was of the opinion that regardless of the number of intermediate ribs all the forms occurring in Southern India should be considered as one and the same species, for which he adopts the name *Vola quinquecostata*. Inasmuch as the forms with three intermediate ribs have never been found in any lower horizon than the Ariyalúr series, I do not see why the specific name of *quadricostata* should not be retained for these forms. It would certainly not be advisable to call the Baluchistán forms by the specific name *quinquecostata*, when they exhibit, without exception, three instead of four intermediate ribs.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Genus : PECTEN, Klein.

PECTEN (CHLAMYS) DUJARDINI, Roemer. Pl. XII. fig. 1-1A.

1841. *Pecten dujardini*, A. Roemer, Norddeutsch. Kreidegeb., p. 53.

1843. *Pecten dujardini*, d'Orbigny, Pal. franc. Ter. crét., Vol. III, p. 615, pl. 439, figs. 5—11.

The only specimen which I refer to this species is unfortunately too badly preserved to permit of a description of the general shape of the shell; all I am able to say is, that both valves exhibit the same ornamentation, and probably differed very little as regards their convexity. The ornamentation consists of 8 broad rounded radiating ribs, separated by interstices of the same breadth. Besides the principal ribs there are much finer filiform ribs equally distributed over the whole surface; there were originally three on each main rib and one in the interstice, but the number gradually increases to 5 on the ribs and 3 in the interstices. Ribs and interstices are crossed by numerous, very regular lamellar striæ of growth, some of which when passing over the secondary ribs, are generally raised into low sharp scales, following each other at regular intervals.

Locality and stratigraphical position.—Dés valley, horizon 2.

Remarks.—It is impossible to discover any difference, as regards the finer ornamentation of the valves, between the Baluchistán form and the well known *Pecten dujardini*: the only difference which I can discover is the larger size and an apparently different number of larger ribs, of which the Baluchistán form exhibits only 8, while there are 11 in the European type. But as the specimen is very much damaged, it is difficult to say whether it did originally exhibit 11 ribs or not. One valve most distinctly shows 9 ribs, and it is quite possible that if the other valve were completely preserved, it would also show the same number. However, I do not think that too much weight should be put on this deviation, as, according to Geinitz¹, the number of the main ribs varies from 9 to 11. Should, however, better preserved specimens prove that the smaller number of ribs is a constant feature in the Baluchistán type, the latter might as well be distinguished as *var. Baluchistánensis* from the European type.

¹ Elbthalgebirge. Palæontographica, Vol. XX, 2, p. 36.

PECTEN (AMUSIUM) sp.

A very ill preserved specimen proves at least the existence of this characteristic type in the cretaceous deposits of Baluchistán.

Locality and stratigraphical position.—Dés Valley, horizon 8.

4. Family: MYTILIDÆ.

Genus: MODIOLA, Lamark,

MODIOLA sp. Pl. X. fig. 5.

A small shell measuring 32 mm. in length and 20 mm. in height probably belongs to this genus; it is equivalve but very inequilateral, the small depressed beaks being quite close to the anterior margin; anterior side short, posterior side elongated and a little expanded. Valves inflated; a shallow furrow runs from the umbo to the posterior end of the straight central margin, thereby slightly cutting out the latter. The ornamentation consists of numerous rather coarse concentric striæ of growth, the interstices of which are filled by very delicate, but somewhat irregular, radiating striæ.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—By its ornamentation this species seems to be related to *Mytilus striatocostatus*, d'Orb., but it is impossible to say anything further, owing to the bad state of preservation of the specimen from Baluchistán, which does not admit even of the shape of the shell being correctly described.

MODIOLA VISHNU, spec. nov. Pl. XI. fig. 3.

The shell, which is tolerably large in size, being certainly not less than 80 mm. in length and about 35 mm. in height, is rectangular in shape, slightly narrower in front than behind; it is very inequilateral, the anterior side being very short, the posterior side elongated, but only slightly expanded. The beaks are low, depressed, and quite close to the anterior margin. A broad but shallow depression runs from the beak towards the central margin, which is thereby slightly indented. Posteriorly the depression is limited by a broad obtuse ridge, on the posterior side of which the surface slopes more steeply than on the anterior. The ornamentation consists of somewhat irregular concentric striæ of growth, which are very fine behind the ridge, but rather strongly marked just in front of it and of the depression; besides the concentric striæ of growth, there are some very fine, closely set, regular, radiating lines, which are limited to the anterior side of the ridge only, where they form a bundle, gradually extending in breadth from the beak towards the central margin.

Locality and stratigraphical position.—Dés valley, horizon 2.

Remarks.—The closest relation to this form is *Modiola typica*, Forbes, from Southern India, a species which exhibits the same bundle of thin radiating striæ

on the anterior declivity of the greatest median convexity of the valves, but this species is readily distinguishable by its broad, expanded, posterior side, and the striæ of growth, which bear exactly the opposite character to those of *Modiola vishnu* by being stronger on the posterior, and finer on the anterior side.

2. Order: HETERODONTA.

Suborder: CONCHACEA.

A. INTEGRIPALLIATA.

1. Family: *ASTARTIDÆ*.

Genus: *CARDITA*, Brug.

CARDITA (*VENERICARDIA*) *BEAUMONTI*, d'Archiac and Haime, var. *BALUCHISTANENSIS*, Noetling. Pl. XII. fig. 2, 2A.

1858. *Cardita beaumonti*, d'Archiac and Haime, Description des Anim. foss. du Groupe Numm. de l'Inde, p. 253, pl. XXI, fig. 14, *a*, *b*.

The bad state of preservation of all the specimens which have come under examination does not permit description of the general shape of the shell. But one fact seems to be certain, that the Baluchistán form has attained a larger size than the Sind type; there is a fragment of a specimen which was certainly not less than 47 mm. in height, while the largest specimen from Sind, which has come under examination, measures not more than 33 mm. in height. Both valves are highly inflated, the beaks are tumid, and strongly rolled inwards. The ornamentation consists of strong and broad radiating ribs, of which those on the posterior side are much thinner than those on the anterior and central part of the surface. On the anterior side the ribs are strongly curved, but they become more and more straight in posterior direction. On the anterior and central part of the surface the ribs are broad and flat, and carry three keels, two sharp ones on either side and a broad and rounded one in the middle. The interstices are about one-half to one-third of the breadth of the ribs, deep and concave. Numerous closely set striæ of growth produce a line of foliaceous granulation on the ribs, particularly on the median ridge.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—It is greatly to be regretted that none of the specimens collected in Baluchistán is complete enough to give an idea of the general shape of the shell, as I suspect that there must exist some constant distinctive features between the types from Baluchistán and Sind, which cannot be overlooked.

As already stated, the Baluchistán types attain a larger size than the Sind ones. Full grown specimens of the latter are of very uniform size, which, as already stated, does not exceed 33 mm. in height. The Baluchistán specimens on

the other hand, show an average height of not less than 40 mm. In accordance with the larger size the ribs are much broader and flatter and the interstices generally narrower than in the Sind specimens. It must also be remarked, that the tripartition of the ribs is much more distinct in all the Baluchistán specimens than in the type from Sind.

Now the question arises, are the differences just mentioned, sufficient to justify a specific separation of the two types or not? From my point of view I contend that a separation of forms which otherwise agree, on features as detailed above, would be going too far. I am inclined to think the different features of the two types represent either local varieties, or perhaps forms belonging to two slightly different geological horizons. The latter question can only be settled when the whole of the fauna of the upper cretaceous systems of Sind and Baluchistán is known, but it may already be remarked, that notwithstanding a great similarity of the upper cretaceous fauna of Sind and Baluchistán, the former contains species which are not yet known from Baluchistán, while the latter has yielded forms which are certainly not known in Sind.

The nearest relation to *Cardita beaumonti*, d'Archiac, appears to be *Cardita inflata*, Leymerie, from the étage Garumnien. Unfortunately M. Leymerie's figure of that species is too defective, and his description too short, to allow of more than attention being drawn to the close similarity between the two forms. It is quite possible that on actual comparison, the two species will be found identical, in which case the specific name *beaumonti*, d'Archiac, ought to receive the priority.

CARDITA (VENERICARDIA) SUBCOMPLANATA, d'Archiac. Pl. XII. fig. 3-3a.

1853. *Cardita subcomplanata*, d'Archiac and Haime, Description des Anim. foss. du Groupe numm. de l'Inde, p. 253, pl. XXI, fig. 11, a, b.

| Dimensions. | | | | | | | | | | | | |
|-------------|---|---|---|---|---|---|---|---|---|---|---|---------|
| Length | . | . | . | . | . | . | . | . | . | . | . | 14 mm. |
| Height | . | . | . | . | . | . | . | . | . | . | . | 15 „ |
| Thickness | . | . | . | . | . | . | . | . | . | . | . | 8 „ (?) |

The small shell is equivalve, suborbicular in shape, and not very inequilateral. The beaks are slightly inflated, depressed, and situated close to the anterior margin. The anterior, central, and posterior margins form nearly a complete circle; but there is a distinct angle at the point where the ventral and posterior margins join. Valves slightly inflated and compressed. The ornamentation consists of 20 radiating ribs, which are slightly curved in the posterior direction; the ribs are angular, of the same thickness and as broad as their interstices; they are crossed by numerous, regular, closely set, concentric striæ of growth, which render them foliaceous. Lunula well defined, heart-shaped and rather broad, but not deep.

Locality and stratigraphical position.—Dés valley.

Remarks.—The Baluchistán forms agree so well with d'Archiac's *Cardita subcomplanata* from Sind, that there can be no doubt as to their identity; it seems that

they are generally somewhat less inflated, although it is difficult to say whether this is a rule, since they are all more or less damaged. Under these circumstances we must suppose that d'Archiac's original came from the upper cretaceous beds of Sind.

2. Family : *CARDIIDÆ*.

Genus : *CARDIUM*, Linné.

CARDIUM LORALAIENSE, spec. nov. Pl. XII. fig. 5-5A.

The cordate shell is equivalve, but somewhat inequilateral; anterior side broad and rounded, posterior side short; beaks inflated, but depressed, closer to the anterior than to the posterior margin. Valves inflated, sloping steeper in the anterior, than in the posterior direction. The ornamentation consists of very regular, moderately broad radiating ribs, which are separated by very narrow interstices. On the posterior and anterior side the ribs are set with low tubercles, but whether the same takes place in the central part of the valves cannot be ascertained owing to the bad state of preservation; to judge from a few pieces of the substance of the shell, they were simply crossed by regular, closely set striæ of growth.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—None of the specimens are sufficiently well preserved to permit a more detailed description at present. To judge from the ornamentation, *Cardium loralaiense* must be a close relation to *Cardium moutonianum*, d'Orb., which differs however, by finer and stronger ribs alternating on the anterior side, and by having the ribs on the central part of the valves covered with fine granules.

CARDIUM HARNAIENSE, spec. nov. Pl. XII. fig. 4-4A.

Although a single left valve only, and this partly imbedded in the matrix, has come under examination, the peculiar ornamentation which it exhibits is sufficient to recognize in it a new species.

The general shape of the shell cannot be definitely ascertained, but it was undoubtedly cordiform, and somewhat higher than long. The ornamentation consists of very regular, rather broad, radiating ribs, separated by interstices of the same breadth. The ribs exhibit a roof-like section, with sharp ridges on the posterior and anterior side, but on the central part of the shell the ridges become flattened and their sides slightly concave. Each rib is accompanied by a very fine line running at either side along its basis on the central part of the shell, and a single line along the posterior side of each rib on the posterior part of the shell. Numerous closely set, concentric striæ of growth produce a thorny appearance on the ribs while the interstices become more or less foliaceous.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—The peculiar ornamentation as described above, distinguishes this species readily from any other forms.

3. Family : *CYPRINIDÆ*.

Genus : *CYPRINA*, Lamark.

CYPRINA MAZARIANA, spec. nov. Pl. XII. fig. 6-6b.

| Dimensions. | | | | | | | | | | | | | |
|-------------|---|---|---|---|---|---|---|---|---|---|---|---|--------|
| Length | . | . | . | . | . | . | . | . | . | . | . | . | 48 mm. |
| Height | . | . | . | . | . | . | . | . | . | . | . | . | 34 „ |
| Thickness | . | . | . | . | . | . | . | . | . | . | . | . | 22 „ |

The shell is triangular in shape, equivalve, but inequilateral. The beaks are inflated but depressed, and situated in the anterior half of the shell. Anterior margin rounded and passing gently into the slightly curved ventral margin, which forms an obtuse angle with the short, apparently slightly convex, posterior margin. The valves are moderately inflated, and slope very gradually in the ventral direction. A strong rounded keel runs from the beak to the angle of the ventral and posterior margin behind which the surface drops nearly vertically. A second more obtuse keel runs from the beak to the point where the posterior and cardinal margins join ; behind this angle the surface is concave, the two valves forming a deeply hollowed ligamental area. Lunula long and broad. Ornamentation only in the shape of striæ of growth often raised into strong wrinkles.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—This species exhibits a great resemblance to *Cyprina forbesiana* from Southern India. But on comparison it will be seen that the two forms are different. Quite apart from the ornamentation of the anterior part of *Cyprina forbesiana*, which consists of sharp and strong concentric ribs, the general shape of the two species differs considerably. *Cyprina forbesiana* is much longer than it is high, posteriorly elongated, and rather short in front ; in *Cyprina mazariana* there is not such a great difference between length and height, and the posterior side is rather short ; the valves are therefore somewhat triangular in shape in *Cyprina mazariana*, while they are transversely elliptical in *Cyprina forbesiana* ; in the latter species the beaks are much more anteriorly situated than in the former, where they are more median.

The next European relation is the well known *Cyprina ligeriensis*, d'Orbigny, but this form is easily distinguished by its more inflated valves, but particularly by the longer ligamental area.

It also seems that the Baluchistán form exhibits a more circular ventral margin, which is only slightly curved in *Cyprina ligeriensis*.

CYPRINA DESENSIS, spec. nov. Pl. XII. fig. 7-7b.

| Dimensions. | | | | | | | | | | | | | |
|-------------|---|---|---|---|---|---|---|---|---|---|---|---|--------|
| Length | . | . | . | . | . | . | . | . | . | . | . | . | 52 mm. |
| Height | . | . | . | . | . | . | . | . | . | . | . | . | 37 „ |
| Thickness | . | . | . | . | . | . | . | . | . | . | . | . | 24 „ |

The shell is equivalve, transversely elliptical in shape, and rather inequilateral. The anterior side is short and rounded, the posterior side elongated, but somewhat

attenuated. The beaks are slightly inflated, depressed, and situated in the anterior half of the shell. The anterior margin is broadly rounded and passes gradually into the almost straight ventral margin. The posterior margin is short and straight and forms an angle of nearly 90° with the ventral margin. The valves are moderately inflated, and gradually slope towards the ventral margin. A rounded keel, which runs from the umbo to the corner of the central and posterior margin, divides off a gradually sloping posterior area; a second more obtuse keel, running from the umbo to the corner of the posterior margin, limits a long and deep ligamental area. Lunula longer than broad, narrow. Coarse, irregular, concentric striæ of growth form the only ornamentation of the surface.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—The general shape of the shell is more like that of a *Crassatella* than that of a *Cyprina*. The question of the generic position of this species can only be settled satisfactorily when the characters of the hinge are known. It was chiefly the deep groove behind the beaks, probably containing the external ligament and the apparently non-crenulated ventral margin which led me to assume that this species belongs to the genus *Cyprina*. Although closely related in regard to the shape of the shell to *Cyprina mazariana*, it is, however, easily distinguished from it by its more transversely elongated valves. Another distinguishing feature is the more gradually sloping posterior area of *Cyprina desensis*.

From *Cyprina forbesiana* it is easily distinguished by its flatter, less inflated valves, the more median position of the beaks, a narrow but well defined lunula, and a long concave area, just above the posterior hinge margin of the valve in which the ligament is situated.

Genus: ROUDAIRIA, Mun, Chalm.

ROUDAIRIA CRASSOPLICATA, spec. nov. Pl. XII. fig. 8-8a.

Unfortunately only a right valve, which is partly covered with young shells of species of *Ostrea*, has come under examination. The shell is trigonal in shape and strongly inflated. The umbo is prominent, attenuated and strongly curved forwards and inwards. A strong and sharp keel runs from the apex to the junction of the posterior and ventral margin. In front of this keel the surface slopes moderately, while behind it the shell drops very suddenly. There is a second keel on this posterior one, running from the apex to the corner of the posterior and cardinal margin, in front of which the surface is deeply grooved. Behind the keel the surface of the shell is smooth, except for some striæ of growth, but in front of it the ornamentation is quite peculiar. Near the umbo it consists of broad and sharp concentric ribs, separated by broad concave interstices. With increasing size the ribs become pronounced and sharp, and the interstices grow broader and angular, being divided into a narrow and steep dorsal, and a broad, but slightly sloping ventral part. The surface of the shell resembles therefore a flight of low, broad stairs, gradually narrowing from the ventral margin to the apex.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—It is readily distinguishable from other species by its peculiar ornamentation. In *Roudairia cristata*, Stol. sp., from the Ariyalúr series, the horizontal ribs are limited to the anterior part of the valves only, and do not extend as far as the keel. *Roudairia drui*, Mun. Chalm., is distinguished by comparatively longer and narrower folds on the anterior part of the shell, but it is apparently the nearest relation to the Baluchistán form.

It is highly interesting that this genus, which up till now has only been known in the upper cretaceous beds of North Africa and Southern India, should appear in beds of the same age in Baluchistán, which otherwise have hardly any forms in common with the cretaceous beds just mentioned.

B. SINUPALLIATA.

1. Family: CHAMIDÆ.

Genus: CHAMA, Linné.

CHAMA CALLOSA, spec. nov. Pl. XII. fig. 9-9a, 10-10b.

The shell is inequivalve, the left (?) valve considerably larger than the right (?) one; it is irregularly rounded in shape, and inequilateral. The larger (left ?) valve is strongly inflated, the beak tumid, but depressed and slightly rolled in. The ornamentation consists of somewhat irregular, strong, concentric and lamellous ribs, which are separated by broad interstices. The smaller (right ?) valve is flat, its umbo very low, depressed and slightly rolled in; the ornamentation is similar to that of the big valve, but the ribs are much more closely set, and the interstices therefore less broad.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—It is rather strange that the above-described species shows no particular resemblance to any of the cretaceous forms of this genus, but, on the other hand, bears the strongest likeness to *Chama squamosa* from the eocene beds.

2. Family: HIPPURITIDÆ.

Genus: RADIOLITES, Lamark.

RADIOLITES SUBDILATATA, Romanowski, sp. Pl. XIII. fig. 4-4a, 5-5a, 5A.

1884. *Sphærolites dilatata*, Romanowski; Material. Geol. Turkestan, pl. XX, fig. 4 a (non b and c).

This species is chiefly represented by internal casts of the lower valve. The shell has nearly entirely disappeared in most of the specimens, and only a few fragments still adhering to some specimens, permit an idea being formed as to its ornamentation.

The internal cast of the lower valve is generally short, its length seldom exceeding 40 mm., diameter at the upper end is not more than 30 mm., and at the lower end the diameter is about half of that of the upper end. The cast is therefore short and conical, its lower end being more or less straightly cut off, but always somewhat rounded. The lower valve must have spread out into rather a broad foliaceous rim at its upper end, as some specimens distinctly show. Two rather long but narrow dental grooves are always well marked. Surface smooth, but extremely finely striated in a longitudinal direction.

Locality and stratigraphical position.—Dés valley.

Remarks.—The species described above is one of the commonest forms in the Dés valley, where there occurs a special bed entirely filled with the curious conical casts of the lower valve. To judge from Romanowski's figure 4 *a*, the forms which have been found in Baluchistán must be identical with the species which he describes under the name of *Sphærulites dilatata*, but being unable to read the description of this species in the Russian language, I cannot say how far my supposition is correct. But it seems to me that he has described under the name of *Sphærulites dilatata* two species which are apparently different. Fig. 4 *a* represents a slightly tapered, nearly cylindrical cast, cut off straight at the lower end, while fig. 4 *b* represents a short, conical cast, with a pointed end. In Turkestan these two extreme shapes may have been connected by intermediate links, but in Baluchistán the two types are certainly different, not only as regards their shape, but also as regards the ornamentation of the surface. I have therefore separated them, and I shall describe the conical cast under the name of *Sphærulites muschketoffi*.

Stoliczka has described as *Sphærulites mutabilis* a form from Southern India, the internal cast of which resembles *Sphærulites dilatata* to some extent, but the ornamentation of the surface of the shell is entirely different in the two species.

RADIOLITES MUSCHKETOFFI, spec. nov. Pl. XIII. fig. 1, 2-2A, 3-3a.

Like the former species, this form is only represented by internal casts of the lower valve. These do not exceed 45 mm. in length, having a diameter of about 30 mm. at the upper end. They are conical in shape, and resemble a short, truncated slightly curved horn. Two rather long dental grooves are always well marked.

The ornamentation consists of numerous rather coarse longitudinal striæ, which are rendered somewhat irregular by concentric striæ of growth.

Nearly all the specimens prove that the lower valve expanded in a broad, probably somewhat foliaceous rim at the upper end, which was well marked off by a sharp line from the lower conical part of the shell.

Locality and stratigraphical position.—Dés valley.

Remarks.—This species is as common as the former in the Dés valley, but, as I have already remarked, it is easily distinguished from it by the attenuated conical shape of the internal mould of the lower valve. Fragments of the surface of the shell have proved that in *Radiolites muschketoffi* the ornamentation consisted of much coarser longitudinal striæ than in *Radiolites subdilatata*.

3. ORDER : DESMODONTA.

1. Family : *PHOLADOMYIDÆ*.Genus : *PHOLADOMYA*, Sow.*PHOLADOMYA INDICA*, spec. nov. Pl. XIII. fig. 7-7a.

The shell is apparently of moderate size only, the length of the specimen being 44 mm. and its height about 32 mm., transversely oval in shape and very inequilateral. The beaks, which are quite close to the anterior margin, are low, depressed, and slightly tumid; the valves are moderately inflated on the anterior part, but slightly compressed in the posterior direction. The ornamentation consists of about 23 fine radiating ribs, which begin quite close to the anterior margin and extend over nearly the whole surface of the shell. The ribs are all of equal strength, but by the numerous strong concentric striæ of growth they appear to be divided into radiating lines of somewhat irregular low granules.

Locality and stratigraphical position.—Dés valley, horizon 8.

Remarks.—The only species which bears any likeness to the specimen described above, is the tertiary *Pholadomya puschi*, Goldf., if any comparison can be made with a specimen so badly preserved, where one of the chief distinctive features is the general outline of the valves.

PHOLADOMYA TIGRIS, spec. nov. Pl. XIII. fig. 6-6a.

Besides the species just described, there is another cast belonging to this genus, which belongs to a decidedly different species. The shell has apparently attained a considerable length, as, although damaged at the anterior side, it still measures about 93 mm. in length, the height being 56 mm. Its general shape was apparently rectangular, the ventral margin being nearly parallel to the hinge margin, but very inequilateral. The anterior side is very short and apparently cut off straight; the posterior side is elongated but not expanded. Although the anterior margin is not visible, it seems that it was nearly straight and joined the straight ventral margin at an angle of about 90°; hinge margin straight, posterior margin rounded. The beaks are low, depressed, and close to the anterior margin. Valves highly inflated, but somewhat compressed towards the posterior side. Ornamentation consisting of 18 to 20 coarse radiating ribs which spread over nearly the whole surface, beginning quite close to the anterior margin, leaving only a small area free towards the posterior and hinge margin.

Locality and stratigraphical position.—Dés valley, horizon 2.

Remarks.—This species exhibits a great likeness to *Pholadomya elliptica*, Münst., as regards the transversely elongated shape of the valves, but it differs apparently by a much shorter anterior side, and the probably straight anterior

margin. *Pholadomya esmarchi*, Nils., seems also a near relation, but it is easily distinguished from this species by its straight ventral margin.

It is easily distinguished from *Pholadomya indica* by its larger size, more inflated valves and the character of the ribs.

2. Family : *MYIDÆ*.

Genus : CORBULA, Brugière.

CORBULA HARPA, d'Archiac and Haime.

1853. *Corbula harpa*, d'Archiac and Haime, Descr. des Anim. foss. du Groupe Numm. de l'Inde, p. 236, pl. XVI, figs 8, a, b, 9.

This species is only represented by a couple of fragments of the right valve and they are too ill preserved to allow a detailed description. It would hardly have been possible to identify them, if better preserved specimens from Sind had not been available for comparison.

I shall delay a detailed description of this species till I am able to describe the cretaceous fossils from Sind, but it is as well to remark here, that d'Archiac has overlooked a very characteristic feature in the ornamentation of the right valve. He states that it shows nothing but concentric striæ of growth. Now, nearly all the specimens from Sind exhibit on the anterior half of the right valve about six fine, but somewhat irregular radiating ribs, which are rather widely distant from each other. Unfortunately these ribs are so delicate that they become effaced if the surface is in the slightest degree weathered, otherwise they form a very distinctive feature of this species.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

V.—GASTROPODA.

Order : PROSOBRANCHIATA,

Suborder : ASPIDOBANCHIATA.

Family : *TROCHIDÆ*.

Genus : TROCHUS, Linné.

TROCHUS LARTETIANUS, Leymerie. Pl. XIV. fig. 1-1a, 2-2A.

1851. *Trochus lartetianus*, Leymerie, Sur un nouv. type Pyren., Mém. de la Soc. Géol. de France, 2nd Ser., Vol. IV, p. 197, pl. B, fig. 10.

There are several casts, which, to judge from bits of shelly substance which still adhere, probably represent this species. The turbiform shell consists of low, rounded

whorls, which increase very slowly in height, and are separated by a deep suture. The surface is covered with numerous fine revolving ribs which have a scaly appearance from being crossed by numerous striæ of growth. If I am right, the more central of these ribs are generally the strongest.

Locality and stratigraphical position.—Mazár Drik, horizon 8; Dés valley.

Remarks.—The general shape and the ornamentation of the Baluchistán specimens are so nearly the same as those of the form described by Leymerie, that I think I am not wrong in identifying them.

Another closely related form seems to be *Trochus rimosus*, Bink., from the Maëstrichtien, but the Baluchistán specimens show unquestionably more affinity with the former, than with the latter species.

2. Family : *NERITIDÆ*

Genus : *NERITA*, Linné.

NERITA PONTICA, d'Archiac spec. Pl. XIV. fig. 3-3A, 4-4b.

1859. *Nerita ponticum*, d'Archiac Note sur le genre *Otostoma*, Bull. de la Soc. Géol. de France, 2nd Ser., Vol. XVI., p. 874, pl. XIX, figs. 2 and 3.

The shell is subglobose, and consists of about three rapidly increasing volutions; the spire is depressed, the suture simple. The last whorl, which is highly inflated, is a little flattened on its posterior side. The ornamentation of the surface consists of rather strong equidistant longitudinal ribs, which are strongest near the suture, but die out before they have reached half the height of the last whorl; in its lower half only indistinct traces of them can be noticed; ribs and interstices are covered with fine, closely set, rather irregular striæ of growth, which produce a rugose appearance of the surface. On the anterior half of the last whorl a number of shallow, equidistant spiral furrows can be seen, but which are very variable as regards distinctness.

Aperture scarcely seen; outer lip sharp; inner lip not seen.

Locality and stratigraphical position.—Mazár Drik, Hemipneustes beds.

Remarks.—The ornamentation of the shell varies considerably; in one specimen the longitudinal ribs are closely set, so much so that the interstices are less broad than the ribs; on the other specimens the ribs are rather far apart and the interstices are therefore broad. Whether the number of the spiral furrows changes I am unable to say; one specimen exhibits ten of them; in the other they are much less distinct, and probably less numerous. The fine striæ of growth which cover the longitudinal ribs, make it appear as if the former were dissolving into numerous fine striæ at the point from which they become indistinct.

I have not the slightest doubt that the specimens from Baluchistán must be identified with this species, as the ornamentation of the shell is apparently exactly

the same; and although d'Archiac does not mention the spiral furrows on the anterior half of the last whorl, they are distinctly marked on his figures 2a and 3.

Stoliczka has already drawn attention to the fact that *Nerita divaricata*, d'Orb., in its type from Southern India, is probably identical with *Otostoma ponticum*. Now I have before me Stoliczka's originals, and on comparing them with the specimens from Baluchistán, particularly the original of pl. XXIII, figs. 11, 12, I cannot discover the slightest difference. The form from Southern India exhibits all the features of the ornamentation which have been described above as characteristic of *Nerita pontica*. Since the Baluchistán specimens agree so well with *Otostoma ponticum* d'Arch., I think I am justified in considering Stoliczka's *Nerita divaricata* as identical with that form.

This species must have had a world wide distribution, as it ranges from the Pyrenees through Asia Minor, Baluchistán and as far as Southern India.

NERITA D'ARCHIACI, spec. nov. Pl. XIV. fig. 5-5b, 6-6a, 7-7A.

This is one of the most common forms in the upper cretaceous strata of Baluchistán; in the Dés valley it apparently occurs in thousands.

The shell, whose transverse diameter reaches 37 to 40 mm., is subglobose and consists of three inflated whorls which rapidly increase in size. The spire is only slightly prominent, but not so much depressed as in *Nerita pontica*; the last whorl is inflated and just a little concave near the suture. The ornamentation consists of exceedingly fine, regular, and very closely set longitudinal striæ, apparently representing striæ of growth; and if the surface of the shell is worn, stronger and finer striæ alternate very regularly.

Aperture not seen; outer lip sharp; inner lip not observed.

Locality and stratigraphical position.—Very common in the Dés valley, horizon 4; rather rare at Mazâr Drik.

Remarks.—This species is easily distinguishable from *Nerita pontica* by its higher spire, but particularly by the seemingly smooth, finely striated surface of the shell, a character by which it is also distinguished from other species belonging to this genus.

The composite character of the shell which Stoliczka mentions is exceedingly well seen in this species. The outer layer is a black, apparently homogeneous substance, which shows a conchoidal fracture. The inner layer is crystalline and looks as if it were composed of an aggregate of crystals of calcite. The latter, which forms the callosity of the inner lip, is in all the specimens more or less dissolved and replaced by a rocky matrix which adheres so firmly to it that it is impossible to lay the inner lip free. But there is not the slightest doubt, that a large flattened inner lip existed, and that the aperture was rather narrow. If the matrix which covers the inner lip is removed as far as can be done, it may be seen that the crystalline layer below it extends to a considerable distance inside, narrowing the aperture; but ordinarily no trace of this callosity can be seen.

Suborder: CTENOBRANCHIATA.

TÆNIOGLOSSA.

I. HOLOSTOMATA.

Family: *TURRITELLIDÆ*.Genus: *TURRITELLA*, Lamarck.*TURRITELLA*, spec. 1. Pl. XIV. fig. 9.

A turreted shell of moderate size, consisting of more than six volutions, might probably be referred to this genus. The whorls are rather low, and increase only very slowly in height, but they are strongly ventricose, and therefore divided by a deep suture. It seems that they were covered with fine spiral striæ separated by interstices of about double their breadth.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—I refrain from making any distinct statements as to the relationship of the above species. Specimens of this description are so inconstant, in their chief characters, that they might be referred to quite a number of species and probably several genera. The probability is that these specimens really belong to the genus *Turritella*, but they are too badly preserved to permit of any specific determination.

TURRITELLA, sp. 2. Pl. XIV. fig. 8.

A small turritiform shell, consisting of flat, moderately low whorls, proves by its markings that there is another species which most likely belongs to the genus *Turritella*. The ornamentation consists of 5 to 6 equidistant, sharp revolving keels, which are crossed by fine, sharp, longitudinal ribs in such a way that the points of intersection are raised into low tubercles.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—The only specimen which has come under examination is too badly preserved to permit of a definite determination, but judging from its ornamentation it must be different from the other species.

Turritella rigida, Sow., seems its nearest relation, but apparently the number of spiral keels is larger in that form.

TURRITELLA (?) *QUINQUECOSTATA*, spec. nov. Pl. XIV. fig. 10-10A.

This is a most remarkable species which I include only provisionally among the genus *Turritella*, because the striæ of growth seem to indicate a rather broad slit at the aperture.

The shell is turreted; the whorls, which are moderately high, increase very slowly in height and are perfectly flat, all in one plane. There are still six whorls

preserved, and as the apex and the anterior part of the shell are broken off, it must have possessed several more whorls. According to the striæ of growth, the aperture was provided with a broad slit. The ornamentation consists of fine spiral ribs, of which from 5 to 6 form a rather broad band on the anterior side of the whorls: the rib next to the suture is generally the strongest, originating in the combination of 3 or 4 finer ribs. Above this band the surface is just perceptibly concave, and the spiral ribs become more indistinct, but exceedingly fine undulating lines may be seen between them. The striæ of growth produce a somewhat scaly appearance of the surface.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Although the general appearance of this species resembles that of a *Turritella*, its general position must be regarded as provisional only, as the slit at the aperture will not allow its being considered as a true *Turritella*. Here also we must wait until better preserved specimens allow this question to be decided.

Family : *CAPULIDÆ*.

Genus : *CALYPTRÆA*, Lam.

CALYPTRÆA, sp. Pl. XIV. fig. 11-11a.

The cast of a low turbiniform shell probably represents this genus; it consists of four low whorls which increase very slowly in height; the surface is slightly inflated and the suture deep. The last whorl bears a sharp keel which divides it from the concave base.

Locality and stratigraphical position.—Dés valley.

Remarks.—Although I have no doubt that this specimen belongs to the genus *Calyptræa*, I refrain from giving it a specific name because the surface of the shell is not known. It seems closely related to *Infundibulum* (*Calypcopsis*) *cretacea*, d'Orb., but it seems that the latter has rather a higher shell than that of the specimen from Baluchistán. The resemblance between the species is, however, so great that it is quite possible that they may be identical.

II. SIPHONOSTOMATA.

A. ENTOMOSTOMA.

Family : *NERINEIDÆ*.

Genus : *NERINEA*, Defrance.

NERINEA QUETTENSIS, spec. nov. Pl. XIV. fig. 12-12a, 13.

The shell is turritiform, consisting of moderately high, flat whorls, which increase very gradually in height; the shell appears therefore nearly cylindrical.

The suture is rather sharp. The only ornamentation consists of numerous striæ of growth, which indicate by their course that the aperture was provided with rather a deep and broad slit, situated just a little above the middle of the height. Beginning from the suture the striæ of growth are at first bent strongly backwards, but suddenly with a broad sweep they turn inwards in a slightly curved line.

Aperture unknown; internal folds unknown.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—The generic position of this species must remain somewhat doubtful, as it is unknown whether there are any internal folds or not. I based the present generic position on the course of the striæ of growth, which prove the presence of a slit at the aperture. The slit, together with the turreted form of the shell, render it most probable that this species belongs to the genus *Nerinea*.

Among previously described species there is only one to which this form could be compared, viz., *Turritella baugh*, d'Orbigny. This species possesses the same turreted shell, composed of slowly-growing flat whorls, and the striæ of growth prove that it was provided with a slit at the aperture. But in this species there are some very regular revolving lines towards the anterior end of the whorls, which are entirely wanting in the Baluchistán specimens. *Nerinea quettensis* shows quite a different feature towards the anterior side of the whorls. Owing to insufficient material, I am unable to say whether this is only exhibited on the earlier whorls and disappears in large specimens, or whether it represents a different specific character. The specimen, fig. 13, which is much smaller than fig. 12, shows that on the anterior side a slightly concave band runs along the suture, bordered above and below by an indistinct keel, on which the striæ of growth rise in small nodules. The lower keel, which is generally much less distinct, coincides with the suture.

As I have already stated, I am unable to say whether this specimen represents a new species, since the earlier whorls of the type of *Nerinea quettensis* are broken away, but as in other respects, such as the shape of the shell, and the course of the striæ of growth, it agrees so well with the type, I see no reason why it should be separated for the present under a different name.

NERINEA GANESHA, spec. nov. Pl. XV. fig. 1, 2-2a; Pl. XVI.
fig. 1-1a, 2-2a.

This fine species must have attained a considerable size, as the tallest specimen, which is by no means completely preserved, measures no less than 170 mm. in length, the diameter of the last whorl measuring about 105 mm. The shell is turreted, but it seems as if the angle of growth becomes somewhat less with the advancing size of the shell, but this could not be positively ascertained owing to the more or less deformed state of the specimens. This species probably consists of some 20 whorls, of which only 11 are preserved in the largest specimen. The whorls, which are very low, and which only increase very gradually in height, are

separated by a deep, grooved suture; their cross section is rectangular; on the inside of the whorls there are five spiral folds, of which three are considerably stronger than the other two; there are two columellar folds of considerable development, the anterior being larger than the posterior one; the other three are situated on the posterior wall of the whorl, the middle one being the strongest of all; the inner one, very fine and sharp, the outer one broad and rounded. Body whorl somewhat inflated, aperture not seen. Columella very short, apparently solid; surface smooth.

Locality and stratigraphical position.—Mazár Drik.

Remarks.—This beautiful species is easily distinguished by the arrangement of the internal folds from all other turreted species belonging to this genus.

Nerinea requieniana, d'Orbigny, is probably the nearest relation to this species, but it is easily distinguished by having a fold on the outer wall, which is entirely wanting in *Nerinea ganesha*, and only one fold on the posterior wall instead of three as in the latter species.

Family: CERITHIDÆ.

Genus: CERITHIUM, Adamson.

CERITHIUM VISHNU, spec. nov. Pl. XV. fig. 3.

This is unfortunately only a fragmentary specimen, which merely serves for description, but, as the aperture is not preserved, the generic position remains somewhat doubtful. The shell apparently attained rather a large size, as the fragment measures 65 mm. in height, with a diameter of about 34 mm. in the last whorl. It is turreted in shape, with numerous whorls, which increase very slowly in height. The whorls are slightly rounded and the suture is deep. The ornamentation consists of thick, rounded longitudinal ribs, of which there are six to one volution, extending from suture to suture. On the last whorl these ribs disappear at half the height. There are besides some rather broad, flat, spiral bands, separated by narrow furrows which run continuously over the ribs and interstices. There are about five such bands of the same strength on each whorl, and above them come three much finer ones. On the spire and on the upper half of the last whorl three or four indistinct longitudinal ribs are found between two primary ribs, producing low, rounded tubercles on the spiral bands. On the lower half of the last whorl these bands are, however, perfectly smooth.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—I cannot find any species that exhibits a similar ornamentation, although there are undoubtedly forms in the cretaceous deposits of the Gosau which show a similar diversity of stronger and finer longitudinal ribs.

CERITHIUM BUDDHA, spec. nov. Pl. XV. fig. 4, 5.

The turreted shell attains a height of 70 mm.; it consists of more than six moderately high, strongly rounded whorls, which increase very slowly in height. Just below the suture the whorls are somewhat contracted, which makes them appear still more rounded. The ornamentation consists of strong longitudinal ribs, which rise into short compressed spines. There are about six to seven in each volution; ribs and interstices are crossed by numerous fine revolving lines.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—All the specimens are very much damaged, but the abovementioned characters are still recognized; this species is therefore characterized by the latally compressed longitudinal ribs, which rise in short blunt spines, being arranged in continuous lines from the apex to the last whorl and separated by broad interstices on which only fine revolving lines can be seen.

This peculiar ornamentation distinguishes *Cerithium buddha* from all the other species. I cannot find any other form closely related to it, although there is not the slightest doubt that *Cerithium vishnu*, *Cerithium buddha*, together with *C. prosperianum*, d'Orb., or *C. matheronii*, d'Orb. and many others, form a natural group, which is chiefly characterized by strong knob-like longitudinal ribs, arranged in continuous lines from the apex to the last whorl.

CERITHIUM (?) sp. Pl. XIV. fig. 14-14a, 15-15a.

Two moderately large casts of a turreted shell belong perhaps to this genus; the shell consisted of rounded whorls, which slowly increase in height, separated by a deep suture. The last whorl, which is just a little higher than those following the spire, bears a few strong spiral keels; otherwise nothing is known about the sculpture.

Besides the two casts there is a fragment of a shell which, judging from its whole appearance, belongs probably to the same species: to judge from its size it must have formed part of the earlier whorls. The low rounded whorls are separated by a deep suture; the ornamentation consists of four to five rounded spiral keels, of which the centre one is the strongest. In the interstices there are fine revolving lines, while numerous moderately strong transverse and equidistant ribs cross them, producing fine nodules at the point of crossing.

Locality and stratigraphical position.—Mazár Drik, horizon 8; Dés valley.

Remarks.—So far as can be judged from the ill preserved specimens, there is no other species which it resembles; and if better material were at hand, allowing a more definite opinion, it is quite possible that this form might prove a new species.

Cerithium maximum, Bink., bears a distant resemblance, but it certainly differs from the Baluchistán form.

B. ALATA.

Family : *STROMBIDÆ*.

Genus : PUGNELLUS, Conrad.

PUGNELLUS CRASSICOSTATUS, spec. nov. Pl. XVI. fig. 3-3a, 4-4a.

The shell is fusiform, acuminate at each end, and consists of five or six volutions, forming rather a low spire; the last whorl, which is ventricose, occupies at least three quarters of the total height of 45 mm. and terminates in a tolerably long canal. The outer lip is much thickened, and expanded into a roundish wing which is bent somewhat backwards. The ornamentation consists of strong, rounded S-shaped ribs on the last whorl, which begin near the suture and disappear about half way across the whorl.

Aperture scarcely seen, apparently longitudinal and narrow.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Although this form is pretty common, there is only one specimen which has the shell sufficiently well preserved, to show the wing-like expansion of the last whorl, and the strong rounded outer lip. All the others are casts which are, however, easily recognizable by the strong transverse ribs in the upper half of the last whorl.

This form is very closely related to *Pugnellus uncatatus*, Forbes sp., from Southern India; in fact, I first thought the two forms to be identical, but on comparison with Stoliczka's originals I find that *Pugnellus uncatatus* has a larger number of more delicate ribs on the last whorl, and that the anterior canal is much shorter than in *Pugnellus crassicosatus*. Whether the Baluchistán form attains a larger size than *Pugnellus uncatatus* cannot yet be decided, but it appears to be the case. The characters abovementioned are, however, sufficient to distinguish both species, notwithstanding their close relationship.

Pugnellus digitatus is easily distinguished by the horizontal ribs on the last whorl.

PUGNELLUS DIGITATUS, spec. nov. Pl. XVI. fig. 5-5a, 6-6a, 7.

The shell cannot have been less than 50 mm. in height, and had apparently an ovoid shape; the short spire is turreted; the last whorl, which occupies probably a little more than three fourths of the total height, is ventricose, and acuminate towards the anterior end. Suture sharp and deep. The ornamentation consists of a sharp median keel, and very delicate, regular, revolving striæ on the spire. On the last whorl about ten sharp revolving keels appear, which apparently extended to the outer lip. Interstices on the keel are covered with numerous and very regular, delicate, revolving striæ, which are crossed by fine longitudinal striæ of

growth in such a manner as to produce an exceedingly delicate net-like ornamentation. It appears that the posterior end of the outer lip ascended for a short distance along the spire.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—All the specimens which have come under examination are, with one exception, casts in rather a mutilated condition. For this reason the generic determination seemed somewhat difficult at the beginning. Owing to the strong keels on the last whorl, which seemed to indicate a digitated outer lip, I first felt inclined to consider this species as belonging to the genus *Pterocera*, Lam. This view seemed to be supported by a posterior canal, apparently ascending along the spire. The probable continuation of the last whorl, however, seemed incompatible with this view. All the specimens show distinctly that the last whorl did not expand in a horizontally spread wing, but that it continued to run in a spiral line. This was certainly an indication that the aperture of this specimen must have been shaped differently from that of *Pterocera*, Lam., whether it terminated in digitations or not.

On comparing these specimens with such as undoubtedly belonged to the genus *Pugnellus*, I recognized such a strong general resemblance that I have no longer any doubt, that notwithstanding the peculiar ornamentation of the last whorl, these specimens must be considered as belonging to the genus *Pugnellus*. It is to be hoped that future researches will yield some better preserved specimens, to decide this question.

For the present I consider this form as belonging to the genus *Pugnellus*; it is easily distinguished from all the other species of this genus by the horizontal keels on the last whorl.

PUGNELLUS GIGANTEUS, spec. nov. Pl. XVII. fig. 1-1a.

This fine species attained a height of at least 83 mm., but unfortunately there are only two specimens which have come under examination, and these are casts, with only traces of the substance of the shell still adhering. The shell has an ovoid shape and consists of more than five whorls; the whorls which compose the spire are flat and rather low, and increase slowly in height; the last whorl is rather inflated and increases so suddenly in height that it occupies at least two-thirds of the total height. The posterior part of the last whorl slopes slightly towards the suture; the anterior end is somewhat acuminate. The aperture is semi-lunar and fairly broad towards the anterior canal. The ornamentation consists of four to five strong revolving ribs on the last whorl, but it is impossible to say for the moment whether there also existed some finer ornamentation or not.

Locality and stratigraphical position.—Sonári hill, near Khattan.

Remarks.—At the first glance this species seems very much the same as *Pugnellus digitatus*, but on comparing the two some characteristic differences will be noticed. The latter form never attains the size of the former, but keeps within

moderate limits; but the chief distinguishing features are, that the posterior canal does not ascend along the spire in *Pugnellus giganteus*, and that the aperture is much broader towards the anterior end in the latter than in the former. Whether there existed differences as regards the ornamentation of the shell, I am unable to say at present.

Family : *CYPRÆIDÆ*.

Genus : *OVULA*, Brugière.

OVULA EXPANSA, d'Archiac and Haime. Pl. XVII. fig. 3-3c;

Pl. XVIII, fig. 2-2b, 3-3c, 4-4c.

1853. *Ovula expansa*, d'Archiac and Haime; Descr. des Anim. foss. des Groupe Numm. de l'Inde, page 330, pl. XXXIII, fig. 3.

The shell attains a considerable size, the largest specimen being 90 mm. in height, having a transverse diameter of about 65 mm. It is nearly globular, but slightly elongated in the anterior and posterior direction, attenuated at the anterior, expanded at the posterior end; general shape turbinoid. It is difficult to say whether, in specimens which have the substance of the shell preserved, the spire is completely concealed or not; to judge from some ill preserved specimens it was not externally visible, and its position was only indicated by a short protraction of the last whorl. The casts, however, expose a low, nearly flat spire, composed of at least four slightly inflated whorls rapidly increasing in height and thickness. The last whorl is ventricose and strongly inflated towards its end. Aperture sinuous, very narrow and slit-like at the posterior, but slightly broader at the anterior end. Posterior canal very narrow, anterior one short, broad, slightly turned upwards, and transversely cut off. Outer lip smooth, thick and inflated, apparently bearing a flat ridge on the inside; inner lip smooth and not crenulated. Surface apparently smooth.

Locality and stratigraphical position.—Mazár Drik, Dés valley.

Remarks.—Messrs. d'Archiac and Haime have described six species of the genus *Ovula*, but it seems that they themselves were in doubt as to their specific independence. In fact it seems difficult to understand what difference exists between *Ovula depressa* Sow., and *Ovula expansa* d'Arch. and Haime.

Mr. Fedden¹ in his list of the distribution of fossils described by Messrs. d'Archiac and Haime considered *O. purchisoni*, d'Arch. and *O. ellipsoides*, d'Arch. as eocene species ranging from the Ranikot to the Khirthar beds. The horizon of *Ovula depressa*, *O. elongata* and *O. cylindroides*, d'Arch., is unknown, and *Ovula expansa* is with some doubt said to occur in the cretaceous and Ranikot bed.

In the collection of fossils from the *Cardita beaumonti* beds from Sind, two species of *Ovula* are found, which differ distinctly from each other, and which therefore represent decidedly different species. The latter one agrees in every detail with the medium sized specimens from Baluchistán, so that there is no

¹ Mem. Geol. Surv. Ind., XVII, 209.

doubt as to their identity. Both forms fully agree in their characters with *Ovula expansa*, d'Arch. and Haime from Sind, so that no doubt can exist now as to the geological horizon of *Ovula expansa*, d'Arch., which has already been correctly conjectured by Dr. Blanford.

With regard to Messrs. d'Archiac and Haime's other species, I refrain from expressing any further opinion. Messrs. d'Archiac and Haime have figured a moderate sized specimen of *Ovula expansa* which apparently has not attained the same size as in Baluchistán. At Mazár Drik this species is very common and easily recognizable by its globular shell, but unfortunately all the specimens are casts, not a single one having preserved the shelly substance. The latter must have been rather thin as indicated by traces left on a few specimens, but for the present nothing can be said about it except that it was probably smooth. The specimens from Sind leave us in this respect equally in the dark, as they exhibit the same state of preservation as those from Baluchistán.

Ovula expansa, d'Arch. and Haime, seems to have a close relationship to *Cypræa kayi*, Forbes, from Southern India, but this form is easily distinguished by its less globose shape, and a smaller diameter in proportion to the height. The shell appears, therefore, much longer than the globose *Ovula expansa*. This feature is particularly striking when the two species are held side by side with the aperture turned upwards.

OVULA BALUCHISTANENSIS, spec. nov. Pl. XVIII. fig. 1-1b.

I have a single cast from the Dés valley, which undoubtedly represents a species differing from *Ovula expansa*. The shell must have been of considerable size; it measures 82 mm. in height, while its transverse diameter is about 55 mm. It is ovoid in shape; the last whorl, although strongly inflated, is much more acuminate at both ends than in *Ovula expansa*. The spire is not seen, but it apparently formed a short process which was almost enveloped by the last whorl. The outer lip is inflated. The aperture is long, narrow, and nearly straight; so far as can be judged, it retains the same breadth throughout its length, and does not contract towards the posterior and expand towards the anterior end.

Locality and stratigraphical position.—Dés valley, horizon 4.

Remarks.—At first glance it is not easy to distinguish this species from *Ovula expansa*, but on comparing the two, a marked difference will be noticed in the shape of the shell. In *Ovula baluchistanensis* the shell is rather long and does not present the somewhat longitudinally compressed form of *Ovula expansa*. In the latter form the last whorl is much more inflated, particularly on the columellar side of the aperture, while it is much more flattened in the former. There is also the difference in shape of the aperture, which is sinuous in *Ovula expansa* and nearly straight in *Ovula baluchistanensis*.

In addition I may say that it seems that in this species the outer lip is much less inflated and the ridge on its inside much broader. All these features appear to justify the separation of the above species from *Ovula expansa*, d'Arch.

It remains to be decided, however, whether this species does not represent one of Messrs. d'Archiac and Haime's forms. As far as I am able to judge, it bears the strongest similarity to *Ovula elongata*, d'Arch., in general shape, but it seems to differ in the generally larger size, the apparently slightly elevated spire and the more flattened outer lip. Whether these differences really exist or not can only be decided by comparison with Messrs d'Archiac and Haime's original. In the meantime I think it preferable to keep the two forms separate, particularly as nothing is known with regard to the geological horizon of *Ovula elongata*, d'Arch.

RACHIGLOSSA.

Family : *VOLUTIDÆ*.

Genus : *STRIGATELLA*, Swainson.

STRIGATELLA spec. Pl. XVI. fig. 12-12a.

A cast of a mitriform shell might be referred to this species. The whorls, of which there are five still preserved, the apex being broken off, are slightly rounded and separated by a deep suture. At the beginning they increase very slowly in height, but the last whorl grows so rapidly that it occupies more than half of the total height of 50 mm. Aperture unknown, but apparently high and narrow. Anterior canal short and broad.

Ornamentation of surface unknown.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—The general shape of the shell indicates that it is related to the genus *Mitra*, but as no columellar folds have been observed, this position is somewhat doubtful. Pending the collection of better preserved specimens, I place it provisionally under the generic name of *Strigatella*, Swainson.

Genus : *VOLUTA* : Linné.

VOLUTA spec. Pl. XVII. fig. 4.

The pyriform shell attains a height of 100 mm.; the largest specimen, which is considerably damaged, measures 92 mm. in height. It consists of about 3 to 4 low whorls, forming a depressed spire and an enormous ventricose body whorl, which is anteriorly attenuated. As far as can be seen, it ends in a short, broad, anterior canal. The aperture is high, oval, but rather narrow; the outer lip is apparently sharp.

Locality and stratigraphical position.—Mazár Drik, horizon 8; Dés valley, horizon 4.

Remarks.—Casts of all sizes which answer to the above description are pretty common at both localities, but all of them more or less damaged. For this reason I have decided not to give them a specific name, particularly as the ornamentation of the surface is unknown.

The general shape of the shell agrees very well with the species described by Stoliczka as *Melo pyriformis*, Forbes. It differs, however, by being less broad at the posterior end of the last whorl, but broader at its anterior end. As the substance of the shell is not preserved, it is impossible to say whether there existed columellar folds or not in the Baluchistán species. Whether Stoliczka's view of the generic position of *Melo pyriformis*, Forbes, is correct or not, I am not prepared to say; all I wish to point out is, that some casts from the upper cretaceous system of Baluchistán bear a strong resemblance to it.

VOLUTA PSEUDOCOSTATA, spec. nov. Pl. XVI. fig. 13.

The fusiform shell measures about 35 mm. in height, but the apex and part of the spire being broken off, it was certainly much longer. The spire was pretty high and consisted of low whorls, which are slightly concave at the upper part. The last whorl is very high and anteriorly strongly acuminate. Aperture very narrow and high, outer lip sharp. So far as can be made out, the ornamentation consisted, besides numerous fine striæ of growth, of short, rounded nodules, slightly elongated in a longitudinal direction, which were set on a keel which marked the upper concave part of the whorls.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—This species is easily distinguishable from the others by the elongated, slender shape of the shell.

Voluta gasparini, d'Orbigny, seems a related form, but it is easily distinguished by the much longer ribs.

Genus: *VOLUTILITHES*, Swainson.

VOLUTILITHES LATISEPTA, Stoliczka. Pl. XVI, fig. 9, 10.

1868. *Volutilithes latisepta*, Stoliczka, Cretaceous Fauna of Southern India, Vol. II, p. 93, pl. IX, figs. 1 and 2.

Two rather ill preserved specimens may be identified with the above species of Stoliczka's originals. The general shape of the shell was apparently turreted, the spire rather low, and the last whorl about half the height of the shell. The ornamentation consists of numerous long and rather thick, rounded, longitudinal ribs, which are separated by slightly concave interstices.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—According to Stoliczka this species differs from *V. caspareni*, d'Orbigny, by its smaller number of transverse ribs, a shorter spire, but compara-

¹ Memoirs, Geol. Sur. of India, Vol. XVII, page 209

tively higher and less numerous whorls. The specimens from Baluchistán agree so well with Stoliczka's fig. 2 that I have not the slightest doubt that they represent the same species. The only difference which I can discover is, that the ribs are a little more rounded in the Baluchistán specimens than in those of Southern India.

VOLUTILITHES DUBIA, spec. nov. Pl. XVI, fig. 8-8a.

A single cast of a shell, to judge from the ornamentation of the whorls, probably belongs to this genus. It consists of four whorls, but the apex is broken off, as well as a good deal of the last whorl. The whorls composing the spire are rather low, but quickly increase in size, the last whorl occupying fully half of the total height of the shell. The whorls are rounded, the suture deep. The last whorl is anteriorly acuminate. As far as can be ascertained, the ornamentation consisted of rather strong longitudinal ribs, which extend from suture to suture in an oblique direction, becoming thicker and more rounded in the middle than at the ends. There are about ten of these ribs to each volution; the broad interstices are flat, even somewhat concave. Aperture unknown.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—This species bears the strongest resemblance to *Volutilithes latisepta*, Stoliczka, but on close examination it will be found that the two forms are different. As regards the general shape, it is at once apparent that the proportion of spire to last whorl is different in both species. In *Volutilithes latisepta* the spire is comparatively low and the last whorl rather high, in *Volutilithes dubia* the spire is much higher in comparison to the last whorl. There are also a large number of longitudinal ribs, which are much finer in the species from Southern India than in that from Baluchistán, and in the latter they are much less pronounced on the last whorl than on the former.

Genus: *VOLUTOMORPHA*, Gabb.

VOLUTOMORPHA, spec. Pl. XVII, fig. 2.

The cast of an elongated fusiform shell probably belongs to this genus. It shows four whorls still preserved, but must have consisted of more, as the apex is broken off; the spire was pretty high, being composed of moderately high, somewhat inflated whorls, which increase slowly in height. The last whorl, which is strongly attenuated in front, measures about double the height of the spire, and owing to its long slender shape forms a conspicuous feature of the species. There are indications of a rounded keel at about the middle of the height of the whorls, from which the surface slopes towards the deep suture. On the last whorl this keel, leaving the median line, runs high up towards the posterior side of the whorl. Aperture very long, narrow. Outer lip apparently sharp.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Although this species forms very characteristic casts, which are easily recognizable by their peculiar shape, I refrain from giving them a specific name, as the ornamentation of the shell is unknown. In general this species bears a strong resemblance to *Volutomorpha conradi*, Gabb.

TOXIGLOSSA.

Family : *CONIDÆ*.

Genus : *CONUS*, Linné.

CONUS, spec. Pl. XVI, fig. 11-11a.

A single, and unfortunately very badly preserved specimen indicates the presence of this genus. The conical shell, which measures 18 mm. in length, consists of five whorls; there were probably more, but the apex is broken off; the angle of growth is more pointed in the earlier whorls than later on, which makes the profile of this form quite a peculiar one. The upper part of the whorls is slightly inclined, the spire, therefore, although low, is not depressed. The last whorl is pretty high, and acuminate at the anterior end. A round keel, from which the surface slopes slightly towards the suture, runs some distance in front of it, and marks the limit up to which the earlier whorls were involved. Striæ of growth indicate that the position of the slit must have coincided with the keel.

Locality and stratigraphical position.—Mazár Drik, horizon 8.

Remarks.—Although there is not the slightest doubt that the specimen described above belongs to the genus *Conus*, I refrain from giving it a specific name because too little is seen of its distinctive features. So far as can be made out, it was probably smooth, except for a row of low nodules on the keel, and another one just below the suture; but I am not quite certain as regards the latter feature.

VI.—CEPHALOPODA.

1. Order : NAUTILOIDEA.

Family : *NAUTILIDÆ*.Genus : *NAUTILUS*, Breyn.*NAUTILUS SUBLÆVIGATUS*, d'Orbigny. Pl. XIX, fig. 1-1a, 2-2a ; Pl. XX, fig. 1-1a, 2-2b.1840. *Nautilus lævigatus*, d'Orb., Pal. Franc. Ter. Crét., Vol. I, p. 84, pl. 17.1850. *Nautilus sublævigatus*, d'Orbigny, Pal. Franc. Ter. Crét., Vol. II, p. 189.1854. *Nautilus labecki*, d'Archiac and Haime, Descr. des Anim. foss. du Groupe Numm. de l'Inde, page 338, pl. XXXIV, fig. 13, a. b.1865. *Nautilus sublævigatus*, Stoliczka, Cretaceous Fauna of Southern India, Cephalopoda, page 203, pl. V, figs. 1 & 3.

| | I. | II. | III. |
|--|----------|--------|--------|
| Diameter of the shell | 114 mm. | 97 mm. | 92 mm. |
| " " umbilicus | 11 " | 8 " | 8 " |
| Height of the last whorl from the umbilical suture | (?) 69 " | 57 " | ? " |
| " " " preceding whorl | ? " | 47 " | 47 " |
| Thickness of the last whorl | 84 " | 58 " | 68 " |
| Number of septa to one revolution | (?) 36 | ? " | ? " |

The subglobose shell is composed of highly inflated whorls which overlap each other to such an extent that only a narrow but deep umbilicus remains. The remarkable feature of this species consists in the rapid lateral expansion of the body chamber towards its end, so that the shell attains its greatest thickness at the aperture of the body chamber. The ventral side is rounded, the sides slope moderately from the umbilical edge towards the ventral side, into which they gradually pass.

The septa follow each other rather closely and appear nearly straight, exhibiting only a slight sinus on the flanks. The siphuncle is eccentric, very close to the dorsal side. The thin shell is covered with fine striæ of growth, which from their direction apparently indicate the existence of rather a deep ventral sinus at the end of the body chamber.

Locality and stratigraphical position.—Mazár Drik ; Dés valley.

Remarks.—Messrs. d'Archiac and Haime have described four species of the genus *Nautilus* from the "chaîne de Hala." According to Dr. Blanford, *Nautilus labecki* only is found with certainty in cretaceous beds, while it seems rather doubtful whether *Nautilus subfleuriusianus* and *Nautilus forbesi* occur in the same beds. All of them, including *Nautilus deluci*, are found in the Ranikot beds ; *Nautilus labecki* is even said to ascend to the Khirthar beds. Under these circumstances it seems important to compare the Baluchistán specimens with those from Sind, and as the result of this comparison I can assert that whatever the specific value of the form here described as *Nautilus sublævigatus* may be, it is certainly identical with the *Nautilus labecki* from Sind.

Messrs. d'Archiac and Haime's figure is not a good one, inasmuch as it does not exhibit the characteristic expansion of the shell at the end of the body chamber

but the broad and comparatively low, widely overlapping whorls are well represented. I consider the chief characteristic features of *Nautilus sublævigatus* to be its globose shell, low, rounded, deeply overlapping whorls, and the sudden lateral expansion of the shell towards the end of the body chamber. These features will readily distinguish this species from *Nautilus subfleuriausianus*, d'Arch., to which it is otherwise closely related. It is, however, almost certain that the species here described is identical with *Nautilus lævigatus*, d'Orbigny, which shows the same characters of the shell, the globose shape, small umbilicus, and expansion of the end of the body chamber. The only difference seems to exist in the position of the siphuncle, which is certainly nearer to the dorsal side in the *Nautilus labechi* than in *Nautilus lævigatus*. This may perhaps be accidental, and I am by no means convinced that this would affect the specific identity of the two forms, particularly as Stoliczka has described under the name of *Nautilus sublævigatus*, d'Orbigny, a form from Southern India which is unquestionably identical with *Nautilus labechi*, as I discovered by comparison of Stoliczka's original, pl. V, fig. 3, with those from the Sind and Baluchistán specimens. Stoliczka has so ably discussed the differences between *Nautilus bouchardianus*, d'Orb., *Nautilus sphaericus*, Forbes, and *Nautilus sublævigatus*, d'Orb., that I need not dwell at length on this subject.

Another form closely related, if not identical, is *Nautilus charpentieri*, Leym.,¹ but I refrain from expressing a definite opinion without having a specimen of this species for comparison.

NAUTILUS SUBFLEURIAUSIANUS, d'Archiac and Haime. Pl. XX, fig. 3-3a;
Pl. XXI, fig. 1-1a.

1854. *Nautilus subfleuriausianus*, d'Archiac and Haime, Descr. des Anim. foss. des Groupe Numm. de l'Inde, page 337, pl. XXXV, fig. 1, a.

| | |
|--|---------|
| Diameter of the shell | 120 mm. |
| Diameter of the umbilicus | 8 " |
| Height of the last whorl from the umbilical suture | 67 " |
| Height of the last whorl from the preceding whorl | 59 " |
| Thickness of the last whorl | 65 " |
| Approximate number of septa to one volution | 40 |

The discoid shell is laterally compressed; at an early age, when the diameter of the shell was not more than 6 mm., the shell was apparently perfectly globose, the thickness of the whorls greatly exceeding their height; with advancing age the height increases more quickly than the thickness, and the proportion of height to thickness, which in early stages is 4 : 8, changes later on to 22 : 39; thus in adult specimens the height exceeds the thickness of the whorls. At the same time the whorls overlap each other so completely that only a very narrow umbilicus remains, which was probably filled by a callosity. The cross section of the whorls is therefore transversely elliptical in younger, sagittate in adult specimens.

The shell attains its greatest thickness at the umbilical edge, and from there the somewhat flattened sides slope towards the rounded ventral side.

¹ Mém. de la Soc. Géol. de France, 2nd Ser., Vol. IV, p. 198, pl. C, fig. 2.

The septa are numerous and follow each other very closely; the suture line is slightly curved, exhibiting a moderately deep but broad lobe on the sides, and a broad, flat, ventral saddle. The siphuncle is eccentric, nearer the dorsal than the ventral side, about one third of the way along the dorso-ventral line.

The body chamber measures about half a volution, and does not expand at its end.

The shell is moderately thick, smooth, and covered with numerous ill defined striae of growth, the direction of which indicates the existence of a deep ventral sinus at the mouth of the body chamber.

Locality and stratigraphical position.—Mazár Drik; Dés valley.

Remarks.—The species here described is easily distinguishable from the foregoing one by its less globose and laterally compressed shell—a character which is best exhibited in the cross section. In *Nautilus sublævigatus* the lateral height and thickness exceeds the ventro-dorsal height, while in *Nautilus subfleuriusianus* the opposite takes place. The cross section of the former is nearly semicircular, while it is sagittate or ovate in the latter. The body chamber of *Nautilus subfleuriusianus* never expands like that of *Nautilus sublævigatus*, which is another distinguishing feature.

I have compared specimens from Sind with those from Baluchistán, and have proved the identity of the two forms. It seems noticeable, that in Sind as well as in Baluchistán, *Nautilus subfleuriusianus* is the rarer species of the two.

I agree with Messrs. d'Archiac and Haime that this species is very closely related to *Nautilus fleuriusianus*, d'Orbigny, which differs, however, by a still more compressed shell and a narrower, less rounded, ventral side.

Stoliczka¹ has described as *Nautilus fleuriusianus* a form from Southern India which, although being somewhat defective, is most probably identical with d'Orbigny's species. In fact, Stoliczka seems to have expressed his doubts by describing it as a variety of this species. But whatever its specific value may be, it is certain that it differs from *Nautilus subfleuriusianus* in the shape of the ventral side; although rounded on the earlier whorls, it is clearly seen on Stoliczka's original that the ventral side becomes more acuminate, a blunt but distinct keel gradually forming—a feature which has apparently not been noticed by Stoliczka.

Family: *AMMONITIDÆ*.

2. Order: AMMONOIDEA.

Genus: INDOCERAS, gen. nov.

In 1876 Meek² established the genus *Placenticeras* for a remarkable group of cretaceous ammonites, which he subdivided into two subgenera, *Placenticeras*

¹ Cretaceous Cephalopods of Southern India, page 207.

² Report of the United States Geological Survey of the Territories, Vol. IX, p. 463.

sensu stricto and *Sphenodiscus*. The latter genus has been characterized by its author as follows:

"Shell with periphery cuneate; umbilicus very small; volutions each almost entirely embraced by the succeeding one; septa with the first five or six lateral sinuses provided with only a few short, nearly simple, obtuse divisions, while the others are simple and usually broadly uniform at the ends." Meek considers *Sphenodiscus* as a subgenus of the genus *Placenticeras*, the most marked features of which are according to him, the lenticular form of the shell, the very narrowly truncated or sharply cuneate periphery; broad, deeply embracing volutions, sagittate aperture, small umbilicus and numerous not very large or very deeply divided lobes and sinuses, arranged in undulating series across each side, the lateral lobes increasing in size to the third one, which is always the longest of the entire series, and those beyond in all cases regularly decreasing in size to the umbilical margin.

Owen has considered *Ammonites lenticularis* as the type of the genus *Sphenodiscus*, but Meek further remarks that it also probably includes *Ammonites pierdenalis*, von Buch.

In his memoir on the Ammonitiden der Hilsbildungen¹ Neumayr apparently takes a different view. He considers the following species—

Ammonites placenta, Dek.,
 „ *guadaloupæ*, Rømer.,
 „ *orbignyanus*, Geinitz.,

which Meek has considered as types of his subgenus *Placenticeras*, as types of this author's subgenus *Sphenodiscus*, and those forms which Meek has considered as types of the latter genus, represent the types of Neumayr's new genus *Engonoceras*. The reason of this was apparently, that Neumayr considered *Placenticeras* a barbarous term which ought to be suppressed, but it cannot be said that Neumayr's suggestions were particularly well chosen. In fact, serious objections might be raised against changing a name, simply because it is grammatically incorrect.

Zittel² has apparently not accepted Neumayr's views, as he acknowledges the independence of the genera *Sphenodiscus*, Meek, and *Placenticeras*, Meek, but he considers the first one as a subgenus of the genus *Buchiceras*, Hyatt, which according to Neumayr belongs to quite a different section of the genus *Amaltheus*, viz. those with a normal number of lateral lobes, while *Sphenodiscus* and *Engonoceras* represent the section with a larger number (three and more) lateral lobes. According to Zittel the subgenus *Buchiceras* comprised all the forms with a normal number of lobes, the external saddle of which, although being broad, was not subdivided by adventitious lobes.

The genus *Sphenodiscus* includes those forms in which the external saddle was divided by adventitious lobes into three branches of unequal size.

* *Placenticeras* forms an entirely independent genus according to Meek.

¹ Palæontographica, Vol. XXVII, p. 140.

² Handbuch der Palæontologie, p. 450.

It cannot be said that under these circumstances the position of this remarkable group of ammonites generally known as "cretaceous ceratites" is quite clear and it is a great convenience that Douvillé¹ in his able paper on the "Classification des Cératites de la Craie," has endeavoured to settle the relationship of these forms.

One of the chief facts elucidated by this author is that the relationship of the genus *Buchiceras*, Hyatt, is uncertain for the present, and that certainly some of the forms which have been considered to belong to this genus must be separated from it. M. Douvillé distinguishes two groups: the first, the family of the *Pulchellidæ*, includes the genera *Stoliczkaia*, *Scaphites*, *Tissotia*, *Pulchellia*, *Neolobites*, and the second includes the genera *Placenticeras* and *Sphenodiscus* which the author includes among the family of the *Hoplitidæ*, while Neumayr was of opinion that they belonged to the family of the *Amaltheidæ*.

Douvillé has, therefore, returned to Meek's limitation of the genera *Placenticeras* and *Sphenodiscus*, but he considers them related to quite a different family to Zittel or Neumayr. Without touching here upon this delicate question, I must draw special attention to two species of Ammonites of the above group which occur in Baluchistán, as one at least apparently represents a new genus.

If we suppose that in the form described as *Sphenodiscus acutodorsatus* the first lateral lobe is represented by the third lobe, counting from the siphonal lobe, as being the largest, then the external saddle is exceedingly broad and divided by two adventitious lobes, the inner one of which is larger than the outer one, and nearly as deep as the first lateral lobe. Of the three branches into which the external saddle is thus divided, the two outer ones rise from a common basis. To judge from this development of the sutural line, this form must belong to the genus *Sphenodiscus*. If, on the other hand, the sutural line of *Indoceras baluchistanensis* is analysed, it will be seen that if the same view were applied to this species, the inner adventitious lobe would be much broader and deeper than the first lateral one—a view which it would be rather difficult to accept, particularly as regards the sutural line of the largest specimen. If, in the case of the latter, the largest lobe be considered as the first lateral, then the external saddle is divided by a single adventitious lobe into two secondary branches. In this case, however, a fundamental difference would exist between the two species here described, and the latter species could not be considered as belonging to the genus *Sphenodiscus*, which is characterised by two adventitious lobes and a tripartite external saddle. If we examine the genera defined by M. Douvillé, we notice that the genus most closely related to the above form would be the genus *Tissotia*, Douvillé, which is characterised by a bipartite external saddle: but on comparing the sutural lines of this genus, as depicted by Douvillé, I think they differ considerably from the sutural line of *Indoceras baluchistanensis*; not only is the secondary lobe much deeper and more independent in the Baluchistán specimens than in any of the species belonging to the genus *Tissotia*, but there exists also a larger number of auxiliary lobes than in that genus. For this reason I do not think that this form can be considered as belonging to *Tissotia*. We are

¹ Bulletin de la Société Géologique de France, Vol. XVIII, p. 281.

therefore obliged to suppose that the form described as *Indoceras baluchistanensis* really represents a new genus, which is characterised by a bipartite external saddle, divided by a deep and broad adventitious lobe, and numerous auxiliary lobes.

I fully realize the inadvisability of establishing a new genus on characters which have been deduced from a single species only, and are not confirmed by being common to a number of species; but following the development of the sutural line of *Indoceras baluchistanensis*, I cannot admit that the largest lobe should not be homologous to the first lateral of other Ammonites, but should represent a second adventitious lobe. The diagnosis of the genus *Indoceras* would, therefore, be as follows:

Shell discoid, consisting of rather high whorls, enveloping each other so fully that only a very narrow umbilicus remains. Sides flat, in the earlier stage provided with indistinct radial ribs, which become effaced in later age. Siphonal side sharp in young specimens, flattened, with an indistinct median keel, accompanied by an obtuse rounded keel on either side, in adult specimens. Siphonal lobe broad and short; first lateral broad and short, denticulated; second lateral lobe much shorter and narrower than the first one; about six very short and narrow auxiliary lobes, of which only the first two are denticulated. External saddle rounded, rather broad, divided by an auxiliary lobe of considerable depth into two branches; other saddles rounded, short, but much broader than the lobes.

INDOCERAS BALUCHISTANENSIS, spec. nov. Pl. XXI. fig. 2-2a, Pl. XXII. fig. 1-1b, 2-2b, 3-3a, Pl. XXIII, fig. 1, 2-2a.

| | I. | II. | III. | IV. |
|--|---------|--------|---------|---------|
| Diameter of the shell | 60 mm. | 65 mm. | 80 mm. | 103 mm. |
| Diameter of the umbilicus | 4 " | ?" " | 4 " | 4 " |
| Height of the last whorl from the umbilical suture | 33 " | 35 " | 44 " | 58 " |
| Height of the last whorl from the preceding whorl | 20(?) " | 21 " | ?" " | 31 " |
| Thickness of the last whorl | 15 " | 19 " | 21 " | 25 " |
| Approximate number of septa to one volution . | 26-28 " | ?" " | 28-30 " | ?" " |

The shell is apparently of moderate size and discoid; the diameter of the largest specimen, which must be a full grown one, to judge from the closely following septa at the end of the body chamber does not exceed 125 mm. in diameter.¹ It consists of rather high laterally compressed flat whorls, which overlap each other so completely that only a very narrow umbilicus remains, which was probably nearly filled by a shelly callosity.

The smallest well preserved specimen, which apparently retains the body chamber to its full length, exhibits some interesting features regarding the character of the siphonal side and the changes which this undergoes during the growth of the shell. At the time when the shell barely exceeded 40 mm. in diameter, the sides were very flat, but showed a line of very indistinct radially elongated nodules, close to the siphonal edge, apparently the last remains of very flat and broad radiating ribs, which became somewhat thickened towards the upper end.

¹ The specimen is not fully preserved, but to judge from the lower part of the end of the body chamber, it must have been approximately of this size.

The siphonal side is very narrow and bears a sharp keel. The sutural line at this stage is very simple. The siphonal lobe is broad, but very low; the first lateral lobe is narrow and short, slightly denticulated at its lower end; the second lateral lobe is similar to the first one, but a little shorter; then follow five very short and narrow auxiliary lobes, which are not denticulated. The rounded external saddle is low, but very broad, and divided by a short denticulated lobe into two branches of about equal breadth; all the other saddles are short, broad, and simply rounded.

At a diameter of about 52 to 54 mm. the sides become slightly tumid and slope towards the siphonal side, so that the greatest thickness of the whorl is close to the umbilicus; at the same time the siphonal side gradually widens out, and the median keel becomes less sharp, but on either side of it there appears an obtuse, rounded keel. The tubercles on the sides have either entirely disappeared or have become so indistinct that they are only visible in a favourable light.

With increasing size the siphonal side becomes more and more flattened, and the median keel more and more indistinct until it entirely disappears in full grown specimens. The sagittate cross section of the whorls in young individuals thus gradually changes into an elliptical one in adult specimens.

The sutural line undergoes very few changes; the saddles always remain low and much broader than the lobes; of the latter the first and second become indistinctly denticulated. As the shell grows, saddles and lobes increase slowly in size, and the denticulation of the auxiliary lobes advances further inwards.

In the largest specimen a remarkable change takes place in the shape of the sutural line, and if the former ones did not exhibit the outline just described, one might feel inclined to consider this specimen to be a different species. The secondary lobe, which divides the external saddle, becomes so deep and broad that it attains nearly the same size as the first lateral one. On the other hand, the two branches of the external saddle, as well as the first lateral one, become very narrow and high. At the first glance this sutural line shows a very different form from that of smaller specimens, but on tracing it back, it may be noticed how, with the deepening of the secondary lobe, the two branches of the external saddle and the first lateral one gradually stretch, while becoming narrower.

Full grown specimens show hardly any traces of the radiating tubercles, unless perhaps a slight roughness of the shell betrays their previous existence.

Most of the specimens have the shell almost entirely preserved; it is very thin, barely 1 mm. in thickness, and perfectly smooth except for numerous striæ of growth; beginning from the sutural line these striæ first bend strongly towards the aperture till about two thirds of the height is reached; then they curve backwards slightly but immediately turn to the front, and forming a short projection on the siphonal side. If from the run of the striæ of growth a conclusion may be drawn as to the shape of the aperture, it might be supposed, that the latter was provided with two short but broad, rounded lateral ears, separated by a shallow and narrow sinus from a short, square, siphonal process.

Locality and stratigraphical position.—Mazár Drik.

Remarks.—This species is easily distinguished by its sutural line; the external

saddle does not show in any of the related species such a large and deep secondary lobe as in *Indoceras baluchistanensis*. *Tissotia ewaldi* shows a suture line which in this respect closely resembles that of *Indoceras baluchistanensis*; but quite apart from the fact that *Tissotia ewaldi* has a smaller number of auxiliary lobes, the inner branch of the external saddle is much higher and broader than the outer one, while in *Indoceras baluchistanensis* the two branches are of nearly the same strength and height, although the inner one is perhaps slightly higher.

So far as I can judge, *Indoceras baluchistanensis* exhibits the greatest differentiation of the external saddle of all the specimens belonging to this group.

Genus: SPHENODISCUS, Meek.

SPHENODISCUS ACUTODORSATUS, spec. nov. Pl. XXI, fig. 3-3A.

| | | | |
|--|-----------|-------|--------------------|
| Diameter of the shell | | 135 | mm. |
| " " umbilicus | | 7 | " (approximately). |
| Height of the last whorl from the umbilical suture | | 75 | " |
| " " " preceding whorl | | 52 | " (approximately). |
| Thickness of the last whorl | | 30(P) | " |
| Number of septa to one volution | | 40(P) | " (approximately). |

The discoid shell consists of very high whorls, much compressed laterally, which overlap each other so fully that only a narrow and shallow umbilicus remains. The sides are apparently perfectly flat and slope slightly towards the siphonal side; the latter is very narrow and bears a sharp keel up to the end of the body chamber. The body chamber occupies about three quarters of a volution, and, apparently, it suddenly widens out so much towards the aperture that its thickness near the latter is quite double of what it is just above the last septum.

Only one branch of the siphonal lobe is visible, but from that we may conclude that it was rather narrow and not very deep; the first lateral lobe is narrow, but rather deep, and ends in short pointed denticulations; the second lateral is of only about half the length of the former and indistinctly denticulated. There are at least five short narrow auxiliary lobes, of which the two or three first ones are denticulated.

The external saddle is very broad and divided by two secondary saddles into three phylloid branches.

The first two, which are rather narrow, rise slightly, diverging from a common basis; the third branch, separated from the others by a deep secondary lobe, is rather broad and rounded; the other saddles are of the same type, but shorter and always much broader than the lobes.

Locality and stratigraphical position.—Dés valley near Khattan; second specimen, Mazár Drik.

Remarks.—Only two of this species have come under examination, neither of which are particularly well preserved. The better preserved specimen, given by Mr. R. A. Townsend to Mr. Oldham, is much affected by weathering, but it still

shows the characters above mentioned, which are sufficient to establish it as a new species. Unfortunately the exact horizon from which this specimen comes cannot be ascertained.

The second specimen, which was collected by Mr. Griesbach in his horizon 4, is still more damaged, but it shows distinctly the sharp siphonal side, so that notwithstanding it being too imperfect to allow of an examination of the sutural line, I have no doubt that it belongs to the species here described.

Sphenodiscus acutodorsatus is therefore chiefly characterized by its sharply-keeled siphonal side, by which it is readily distinguishable from the broader *Indoceras baluchistanensis*. The sutural line exhibits also some marked differences; in the former the external saddle is divided by a rather deep secondary lobe, while in *Sphenodiscus acutodorsatus* it is divided by two secondary lobes into three branches.

Genus : BACULITES, Lamarck.

BACULITES BINODOSUS, spec. nov. Pl. XXIII, fig. 3-3a.

A fragment of a specimen 90 mm. in length represents this genus; as it is chambered throughout, the complete shell must have been of considerable length. At the lower end the dorso-ventral diameter measures 24 mm., at upper end 31 mm., so the missing part towards the embryonic chamber of the shell cannot have therefore measured less than 250 mm., and the complete shell must have attained a length considerably over 340 mm.

The greatest lateral diameter, which is close to the antisiphonal side, is 14 mm. at the lower end and 18 mm. at the upper end, but it decreases considerably towards the siphonal side. The cross section is therefore egg-shaped.

The sides are flat and slope towards the rounded siphonal side; the antisiphonal is rather broad and somewhat flattened. On either side of the latter there is a row of very indistinct, low and broad tubercles, which are, however, only visible under a favourable light.

The siphonal lobe is rather broad, but not very deep; the first lateral lobe is narrow, deeper than the siphonal lobe, and bipartite; the second lateral lobe is broader than the first, but much less deep, also bipartite; the antisiphonal lobe is very short and narrow, and terminates in one point. The external saddle is narrow and high, but much less so than the first lateral, which is the highest, and bipartite like the former; the antisiphonal saddle is broad and low. Saddles and lobes are deeply denticulated.

Locality and stratigraphical position.—Dés valley: exact horizon unknown, but it is most probable that this specimen was found together with *Sphenodiscus acutodorsatus*, spec. nov.

Remarks.—The specimen above described was given by Mr. R. A. Townsend, who collected it in the Dés valley near Khattan, to Mr. Oldham. Its characters are sufficient to establish a new species. It differs from the other known species chiefly by the character of the sutural line; *Baculites baculoides*, d'Orbigny, resembles the

above specimen somewhat in its sutural line, but it differs from it in the following characters: the first lateral saddle is of the same height as the second lateral (in *B. binodosus* the second lateral is higher), and the first lateral lobe is narrow and of the same depth as the second lateral (in *B. binodosus* the second lateral is much shorter but broader than the first lateral).

With regard to this character, *B. faujasi*, Lam., is perhaps the most closely related form to the Baluchistán specimen; in fact, the features of both species are nearly the same. *B. faujasi* differs apparently by a more delicate sutural line,¹ but chiefly by its more regularly elliptical cross section and the absence of nodules along the artisiphonal side. It is the latter feature, together with the sutural line, which readily distinguishes *B. binodosus*.

VII. ARTHROPODA.

Class: CRUSTACEA.

MALACOSTRACA.

Order: *DECAPODA*.

Suborder: BRACHYURA.

Family: *RANINOIDEA*.

Genus: RANINA, Lamarck.

RANINA GRIESBACHI, spec. nov. Pl. XXII, fig. 4.

Only one specimen of this interesting species has come under examination, and this is in such a mutilated state that only the anterior part of the carapace is preserved. This specimen exhibits the following characters.

The greatest breadth of the anterior part, measured between the second lateral spines, is 58 mm. The front margin, taken as a whole from the base of the rostrum to the first lateral spine, is almost straight. The narrow rostrum, which is unfortunately a little damaged, must have been short, apparently three-pointed, and hollowed by a deep but short longitudinal furrow.

The orbital margin is indented, at about the middle, by two strong incisions, converging in the posterior direction, the outer one of which is slightly longer but

¹ It must be remarked that there are some discrepancies between the sutural line of Binkhorst's fig. 1a and 1b; in the former external and lateral saddle are of the same height, while in the latter the lateral saddle is distinctly higher than the external one. In fig. 1a the first lateral lobe is distinctly deeper than the second one, while they are of the same depth in fig. 1b.

narrower than the inner one. Between these two incisions the orbital margin forms a broad rounded lobe, provided with a short spine; a similar spine appears at either side of the two incisions. There are three lateral spines, of which the first is broad and long, projecting straight in front; this is separated by a deep and broad incision from the second one, which is narrower and obliquely directed; the latter is separated from the short third antero-lateral spine by a very short incision.

The whole surface of the anterior part of the carapace is covered with numerous fine tubercles, which become somewhat coarser in the middle than at the margins. The specimen just shows the first of the fine transverse ridges which cover the posterior part of the carapace, which seems to have been covered also with extremely fine closely set punctures.

Locality and stratigraphical position.—Neighbourhood of Khattan.

Remarks.—*Ranina griesbachi* represents one of the largest species of this genus; it is easily distinguished from all the other species by the formation of its front margin. The deep orbital and lateral incisions divide it into bold lobes, the antero-lateral one of which is provided with two strong spines. In this peculiar feature *Ranina griesbachi* differs from all the other known species, while in the general shape of its front margin it greatly resembles the eocene *Ranina marestiana*, Konig.

It is possible that the species here described belongs to the genus *Raninella*, Milne-Edwards, but as the chief distinction of this genus from *Ranina* consists in the shape of the plastron, which is not visible in the specimen under examination, I refrain from expressing an opinion and take it as belonging to the genus *Ranina*, to which all the characters of the carapace point.

PLATE I.

| | |
|-----------|---|
| Fig. 1. | ORBITOIDES SOCIALIS, Leymerie, natural size. |
| Fig. 1a. | " " " " |
| Fig. 2. | ORBITOIDES SOCIALIS, Leymerie, " |
| Fig. 2a. | " " " " |
| Fig. 2b. | " " " lateral view, enlarged. |
| Fig. 3. | ORBITOIDES SOCIALIS, Leymerie, natural size. |
| Fig. 3a. | " " " " |
| Fig. 3b. | " " " " |
| Fig. 3c. | " " " lateral view, enlarged. |
| Fig. 4. | ORBITOIDES SOCIALIS, Leymerie, natural size. |
| Fig. 4a. | " " " " |
| Fig. 4b. | " " " " |
| Fig. 4c. | " " " lateral view, enlarged. |
| Fig. 4d. | " " " enlarged. |
| Fig. 5. | ORBITOLITES MACROPORA, DeFrance, natural size. |
| Fig. 5a. | " " " " |
| Fig. 5b. | " " " " |
| Fig. 6. | ORBITOLITES MACROPORA, DeFrance, natural size. |
| Fig. 6a. | " " " " |
| Fig. 6b. | " " " enlarged. |
| Fig. 6c. | " " " " |
| Fig. 7. | TROCHOSMILIA PROTECTANS, sp. nov., largest specimen. |
| Fig. 7a. | " " " " " |
| Fig. 7b. | " " " " " (calyx). |
| Fig. 8. | TROCHOSMILIA PROTECTANS, sp. nov., medium sized specimen. |
| Fig. 8a. | " " " " " " |
| Fig. 8b. | " " " " " (calyx.) |
| Fig. 9. | TROCHOSMILIA PROTECTANS, sp. nov. |
| Fig. 9a. | " " " " |
| Fig. 9b. | " " " (calyx). |
| Fig. 10. | TROCHOSMILIA PROTECTANS, sp. nov. (enclosing MODIOLA sp.) |
| Fig. 10a. | " " " " " |
| Fig. 10b. | " " " " |
| Fig. 11. | CYCLOLITES MEDICOTTI, sp. nov., natural size. |
| Fig. 11a. | " " " " |
| Fig. 11b. | " " " enlarged. |
| Fig. 12. | CYCLOLITES MEDICOTTI, sp. nov., natural size. |
| Fig. 12a. | " " " " |
| Fig. 12b. | " " " enlarged (lower side), |
| Fig. 13. | CYCLOLITES REGULARIS, Leymerie, natural size. |
| Fig. 13a. | " " " " |
| Fig. 13b. | " " " " |
| Fig. 14. | CYCLOLITES REGULARIS, Leymerie, natural size. |
| Fig. 14a. | " " " " |

CRETACEOUS FOSSILS OF BALUCHISTÁN.

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Pl. 1.

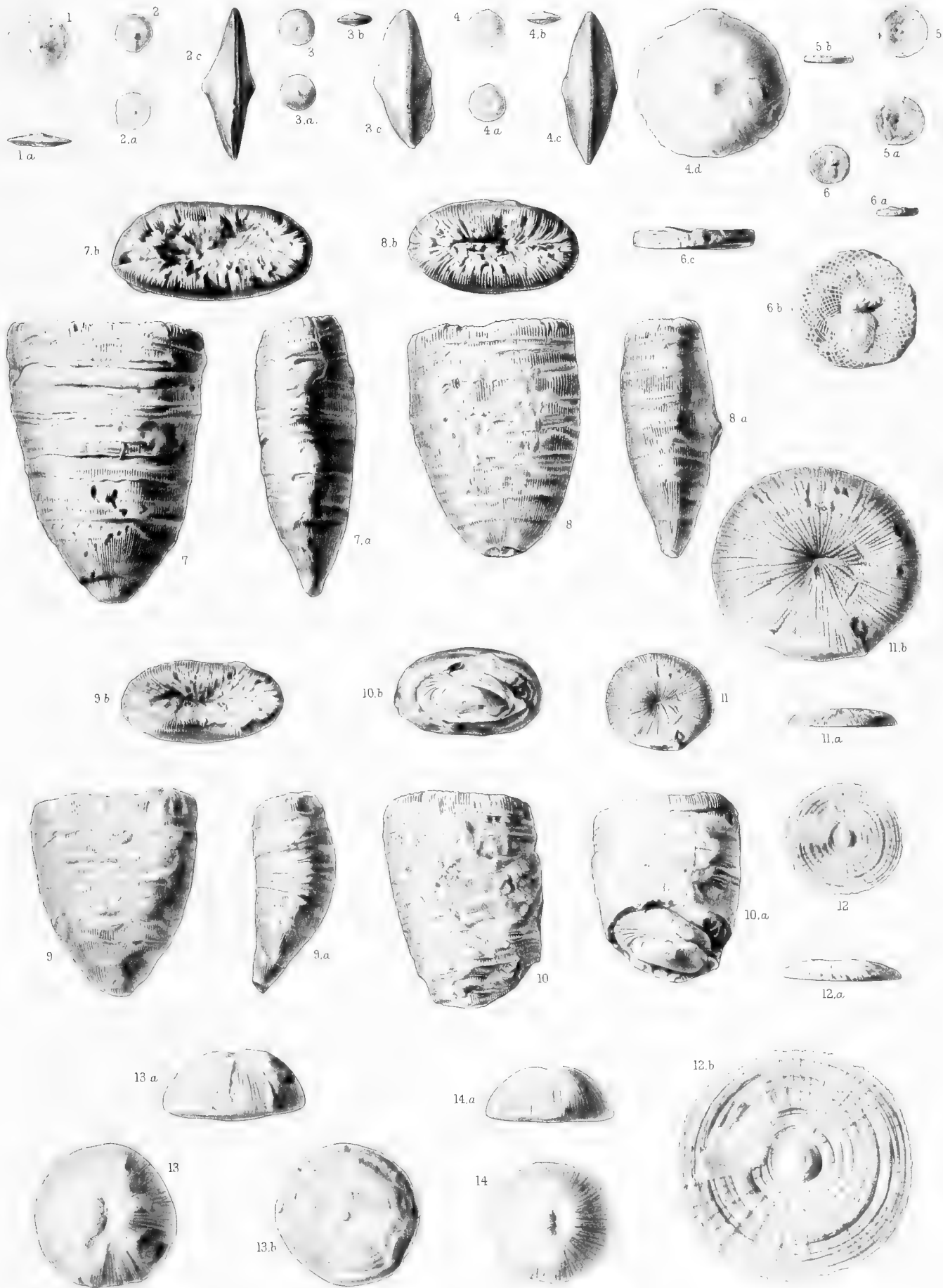


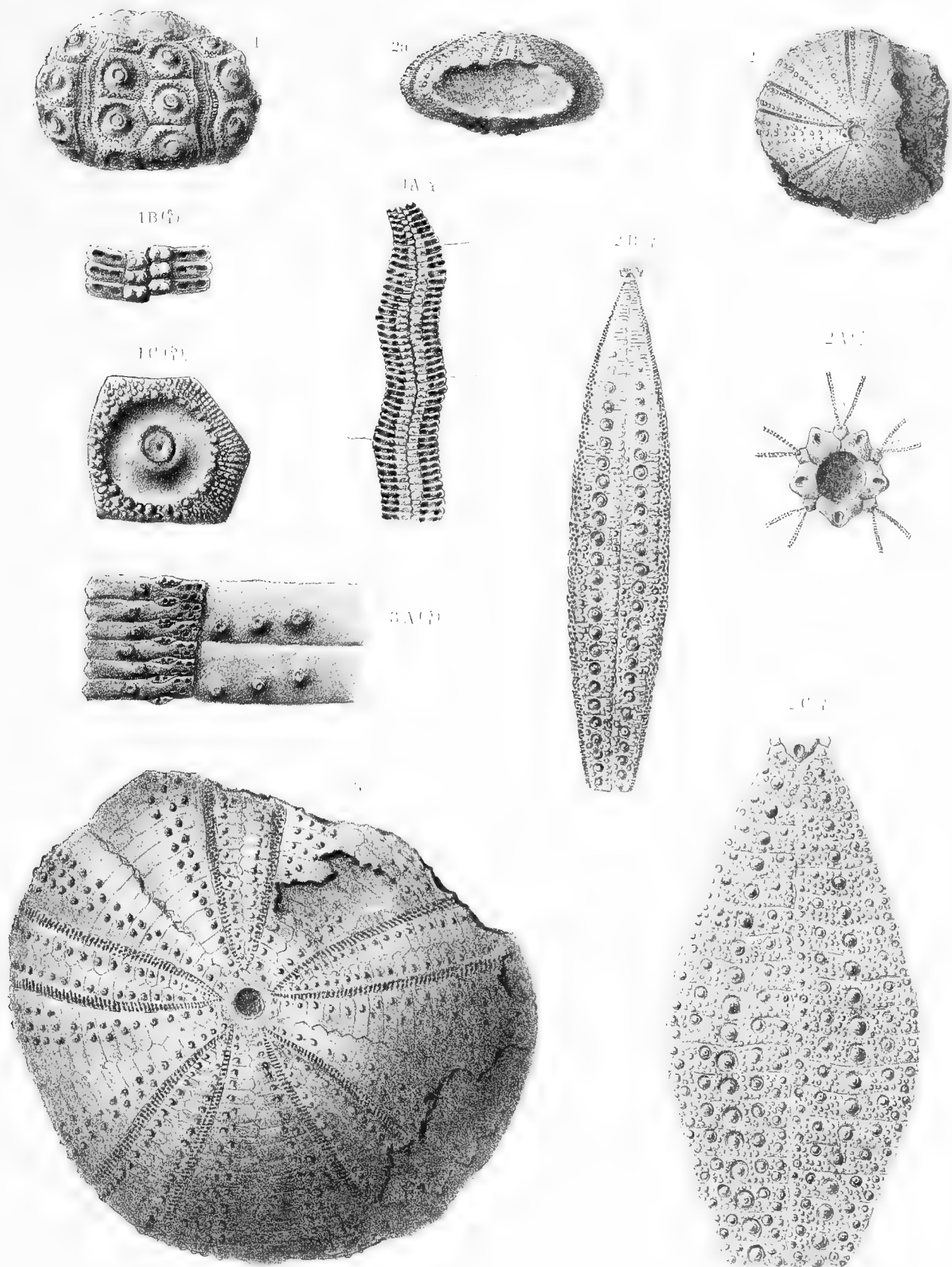
PLATE II.

- | | | |
|----------|--|--|
| Fig. 1. | CIDARIS SULEIMANI, sp. nov., | side view ; natural size. |
| Fig. 1A. | " " " | ambulacrum ; enlarged $\frac{3}{4}$. |
| Fig. 1B. | " " " | part of ambulacrum ; enlarged $\frac{6}{7}$. |
| Fig. 1C. | " " " | interambulacral plate ; enlarged $\frac{3}{4}$. |
| Fig. 2. | ORTHOPSIS PERLATA, sp. nov., | abactinal view ; natural size. |
| Fig. 2a. | " " " | side view ; natural size. |
| Fig. 2A. | " " " | apical disc ; enlarged $\frac{3}{4}$. |
| Fig. 2B. | " " " | ambulacrum ; enlarged $\frac{3}{4}$. |
| Fig. 2C. | " " " | inter ambulacrum ; enlarged $\frac{3}{4}$. |
| Fig. 3. | PROTECHINUS PAUCITUBERCULATUS, sp. nov., | abactinal view ; natural size. |
| Fig. 3A. | " " " | part of ambulacrum ; enlarged $\frac{3}{4}$. |

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Pl II



J. H. Mann direct lith

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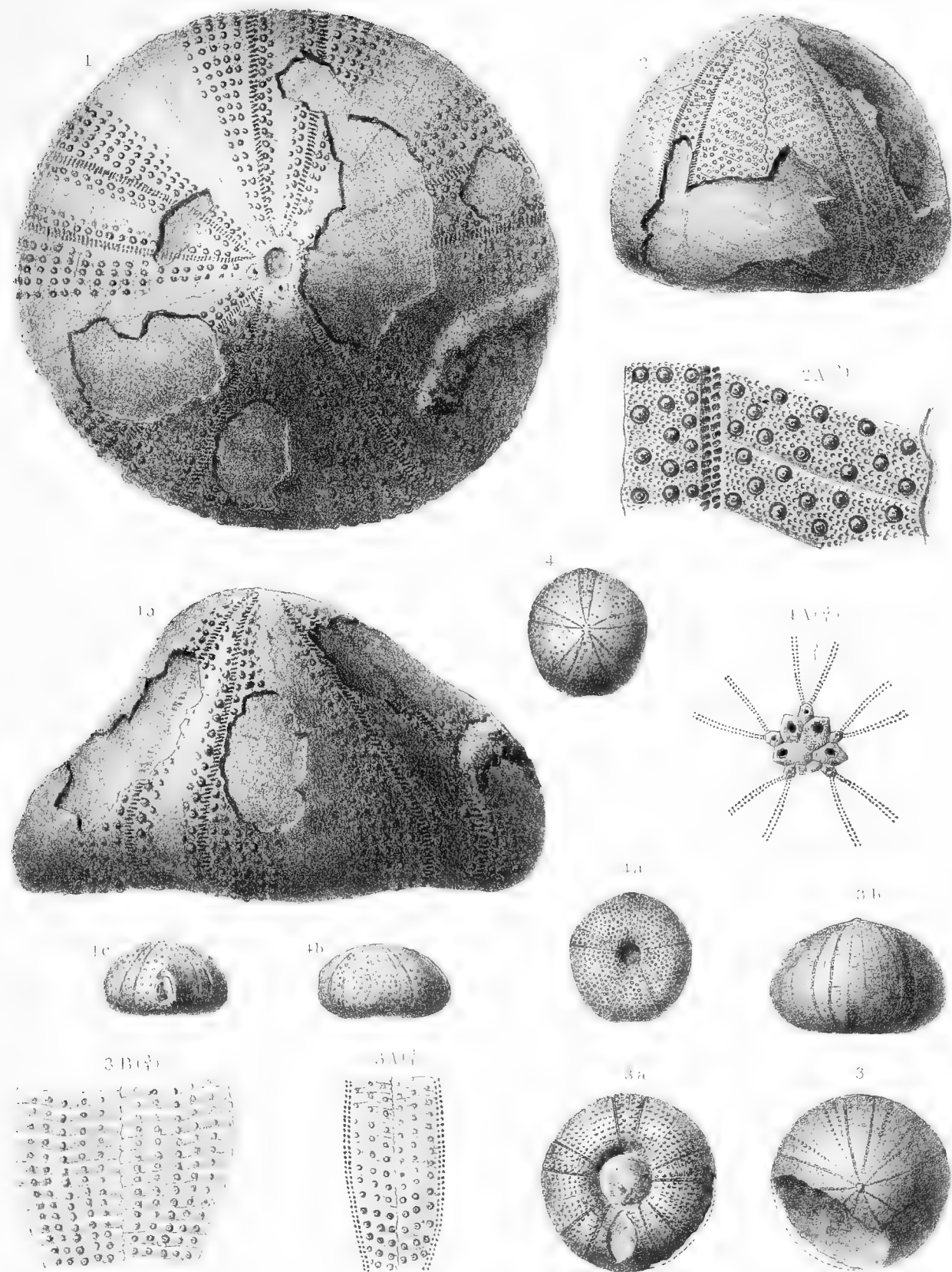
PLATE III.

- Fig. 1. *PROTECHINUS PAUCITUBERCULATUS*, sp. nov., abactinal view ; natural size.
Fig. 1a. " " " side view ; natural size.
Fig. 2. *ECHINOCONUS GIGAS*, Cotteau, side view ; natural size.
Fig. 2A. " " " part of ambulacral and interambulacral area ;
enlarged $\frac{3}{4}$.
Fig. 3. *HOLECTYPUS BALUCHISTANENSIS*, sp. nov., abactinal view ; natural size.
Fig. 3a. " " " actinal view ; natural size.
Fig. 3b. " " " side view ; natural size.
Fig. 3A. " " " part of ambulacrum ; enlarged $\frac{3}{4}$.
Fig. 3B. " " " part of inter-ambulacrum ; enlarged $\frac{3}{4}$.
Fig. 4. *PYRINA ATAXENSIS*, Cotteau, *var. PENTAGONALIS*, abactinal view ; natural size.
Fig. 4a. " " " " " actinal view ; natural size.
Fig. 4b. " " " " " side view ; natural size.
Fig. 4c. " " " " " posterior view ; natural size.
Fig. 4A. " " " " " apical disc ; enlarged $\frac{3}{4}$.

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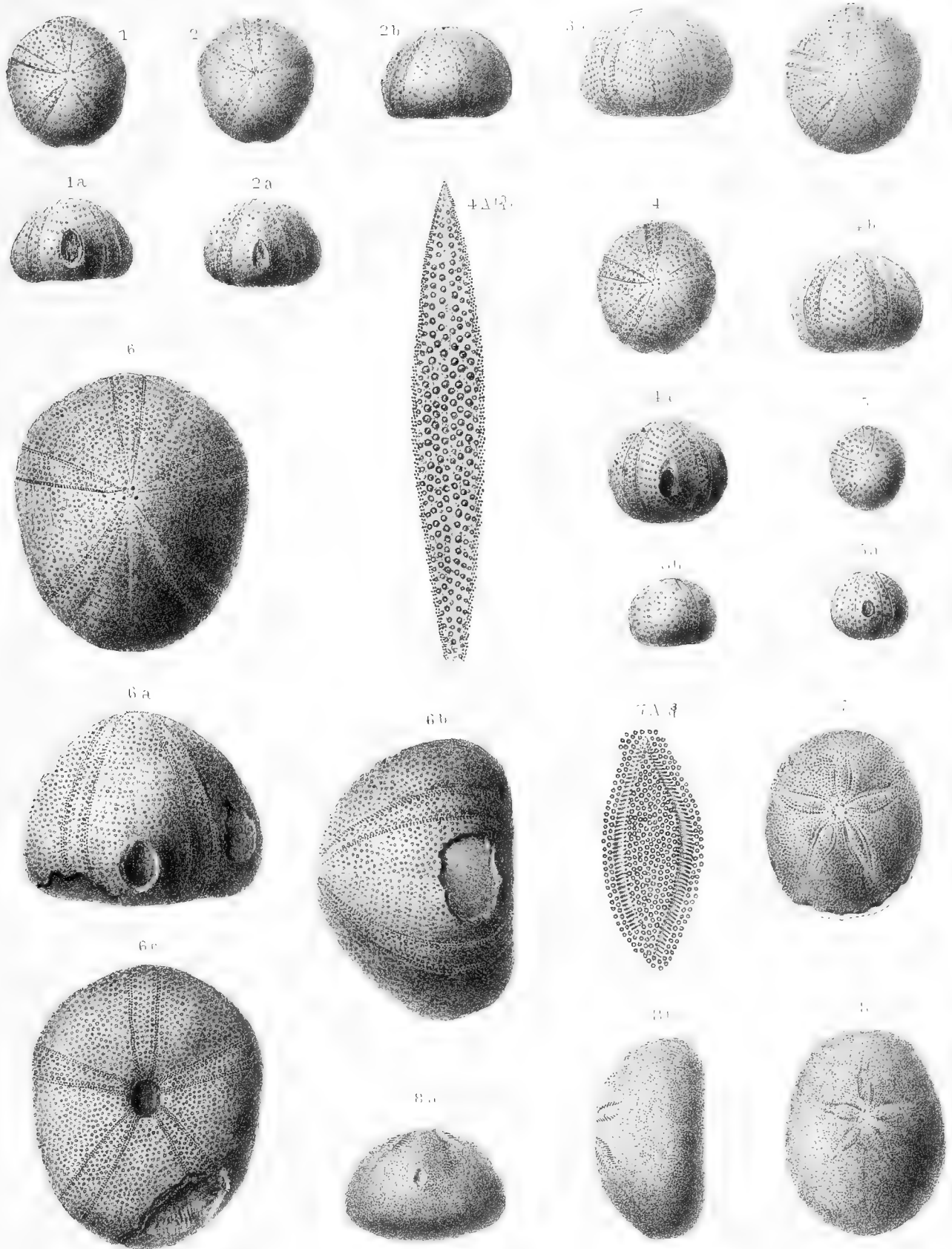
PLATE IV.

- Fig. 1. PYRINA ATAXENSIS, Cotteau, *var.* PENTAGONALIS, abactinal view ; natural size.
Fig. 1a. " " " " posterior view ; natural size.
Fig. 2. PYRINA ATAXENSIS, Cotteau, *var.* TUMIDA, abactinal view ; natural size.
Fig. 2a. " " " " posterior view ; natural size.
Fig. 2b. " " " " side view ; natural size.
Fig. 3. PYRINA ATAXENSIS, Cotteau, *var.* TUMIDA, abactinal view ; natural size.
Fig. 3a. " " " " side view ; natural size.
Fig. 4. PYRINA ATAXENSIS, Cotteau, *var.* GLOBOSA, abactinal view ; natural size.
Fig. 4a. " " " " posterior view ; natural size.
Fig. 4b. " " " " side view ; natural size.
Fig. 4A. " " " " ambulacrum ; enlarged $\frac{3}{4}$.
Fig. 5. PYRINA ATAXENSIS, Cotteau, *var.* GLOBOSA, abactinal view ; natural size.
Fig. 5a. " " " " posterior view ; natural size.
Fig. 5b. " " " " side view ; natural size.
Fig. 6. PYRINA GIGANTEA, sp. nov., abactinal view ; natural size.
Fig. 6a. " " " " posterior view ; natural size.
Fig. 6b. " " " " side view ; natural size.
Fig. 6c. " " " " actinal view ; natural size.
Fig. 7. ECHINANTHUS GRIESBACHI, sp. nov., abactinal view ; natural size.
Fig. 7A. " " " " ambulacral area ; enlarged $\frac{3}{4}$.
Fig. 8. ECHINANTHUS GRIESBACHI, sp. nov., abactinal view ; natural size.
Fig. 8a. " " " " posterior view ; natural size.
Fig. 8b. " " " " side view ; natural size.

CRETACEOUS FOSSILS OF BALUCHISTÁN.

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PL. IV.



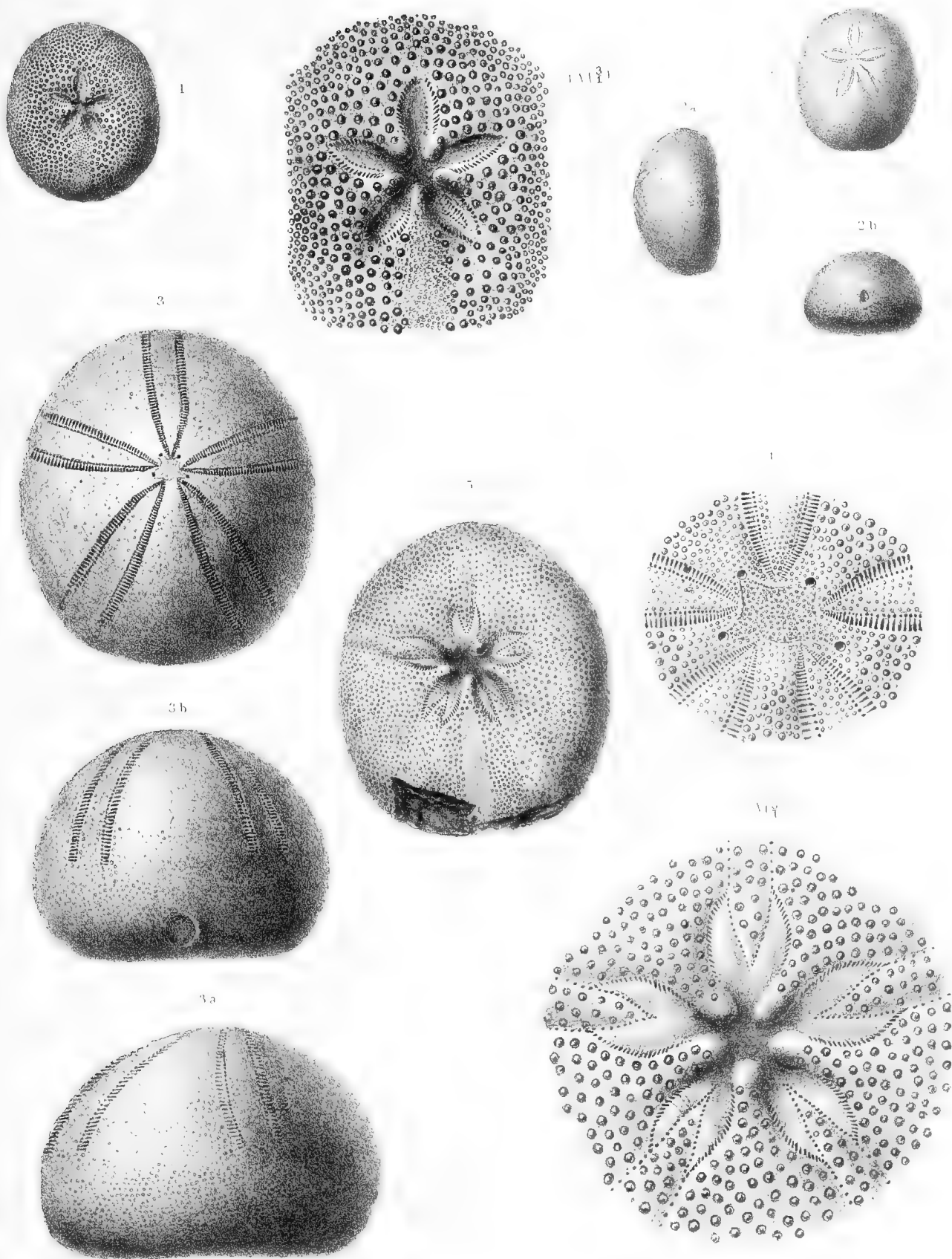
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PLATE V.

- Fig. 1: ECHINANTHUS GRIESBACHI, sp. nov., actinal view ; natural size.
 Fig. 1A. " " " peristome and floscelle ; enlarged $\frac{3}{1}$.
 Fig. 2. ECHINANTHUS GRIESBACHI, sp. nov., abactinal view ; natural size.
 Fig. 2a. " " " side view ; natural size.
 Fig. 2b. " " " posterior view ; natural size.
 Fig. 3. CLYPEOLAMPAS HELIOS, sp. nov., abactinal view ; natural size.
 Fig. 3a. " " " side view ; natural size.
 Fig. 3b. " " " posterior view ; natural size.
 Fig. 4. CLYPEOLAMPAS HELIOS, sp. nov. , apical disc ; enlarged $\frac{3}{1}$.
 Fig. 5. CLYPEOLAMPAS HELIOS, sp. nov., actinal view ; natural size.
 Fig. 5A. " " " peristome and floscelle ; enlarged $\frac{3}{1}$.

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PLATE VI.

- Fig. 1. CLYPEOLAMPAS VISHNU, sp. nov., abactinal view ; natural size.
Fig. 1a. " " " side view ; natural size.
Fig. 1b. " " " posterior view ; natural size.
Fig. 1c. " " " actinal view ; natural size.
Fig. 2. HEMIPNEUSTES PYRENAICUS, Hébert, abactinal view ; natural size.
Fig. 2a, " " " side view ; natural size.
Fig. 2b. " " " posterior view ; natural size.
Fig. 3. HEMIPNEUSTES PYRENAICUS, Hébert, abactinal view ; natural size.
Fig. 3A. " " " ambulacral area ; enlarged $\frac{3}{4}$.
Fig. 4. HEMIPNEUSTES PYRENAICUS, Hébert, side view ; natural size.
Fig. 4a. " " " anterior view ; natural size.

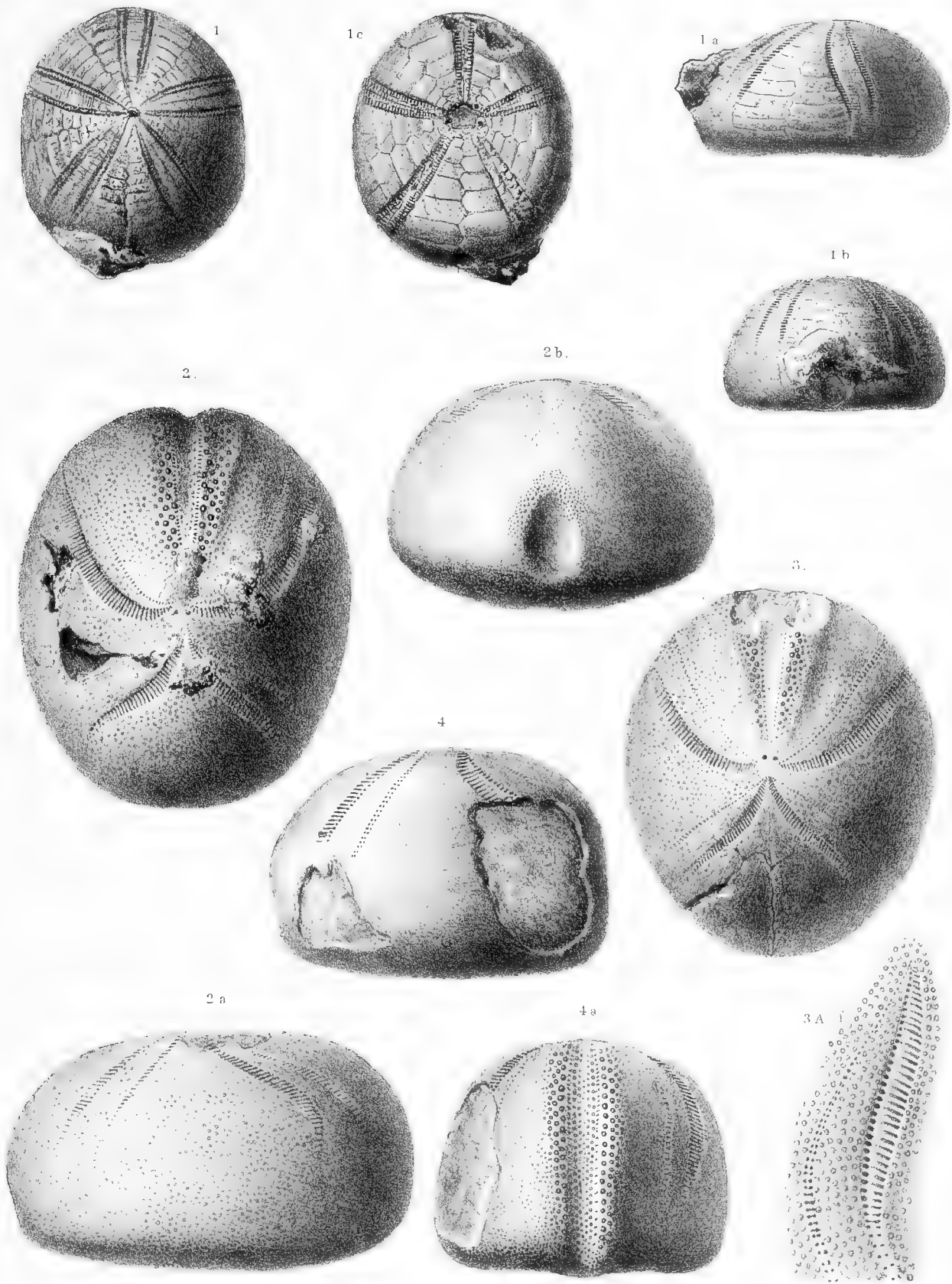


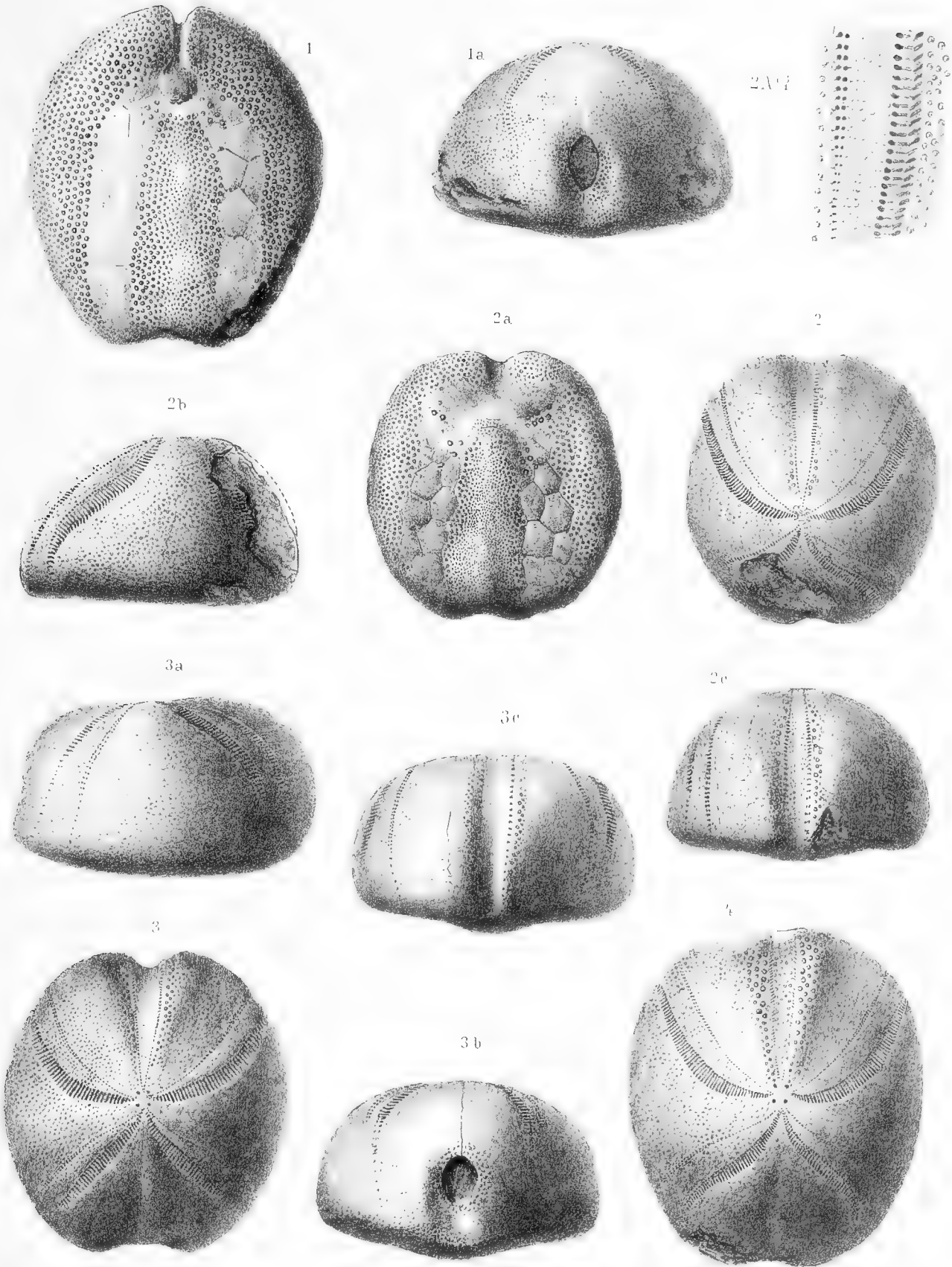
PLATE VII.

- Fig. 1. HEMIPNEUSTES PYRENAICUS, Hébert, actinal view ; natural size.
Fig. 1*a*. " " " posterior view ; natural size.
Fig. 2. HEMIPNEUSTES LEYMERIEI, Hébert, abactinal view ; natural size.
Fig. 2*a*. " " " actinal view ; natural size.
Fig. 2*b*. " " " side view ; natural size.
Fig. 2*c*. " " " anterior view ; natural size.
Fig. 2*A*. " " " part of amubacral area ; enlarged $\frac{3}{1}$.
Fig. 3. HEMIPNEUSTES COMPRESSUS, sp. nov., abactinal view ; natural size.
Fig. 3*a*. " " " side view ; natural size.
Fig. 3*b*. " " " posterior view ; natural size.
Fig. 3*c*. " " " anterior view ; natural size.
Fig. 4. HEMIPNEUSTES COMPRESSUS, sp. nov., abactinal view ; natural size.

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Pl. VII.



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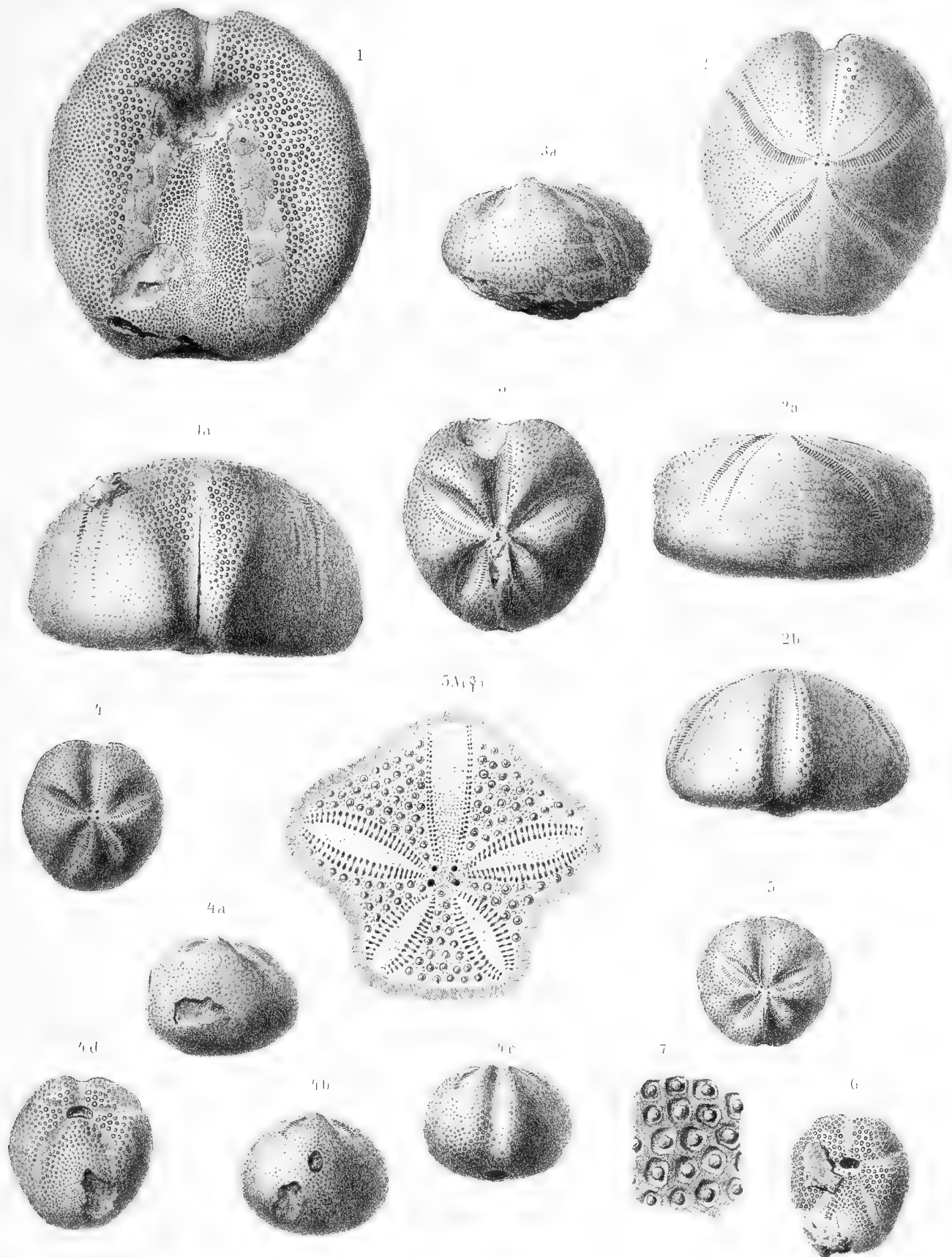
PLATE VIII.

- Fig. 1. HEMIPNEUSTES COMPRESSUS, sp. nov., actinal view ; natural size.
 Fig. 1a. " " " anterior view ; natural size.
 Fig. 2. HEMIPNEUSTES COMPRESSUS, sp. nov., abactinal view ; natural size.
 Fig. 2a. " " " side view ; natural size.
 Fig. 2b. " " " anterior view ; natural size.
 Fig. 3. HEMIASTER BLANFORDI, sp. nov., abactinal view ; natural size.
 Fig. 3a. " " " side view ; natural size.
 Fig. 4. HEMIASTER OLDHAMI, sp. nov., abactinal view ; natural size.
 Fig. 4a. " " " side view ; natural size.
 Fig. 4b. " " " posterior view ; natural size.
 Fig. 4c. " " " anterior view ; natural size.
 Fig. 4d. " " " actinal view ; natural size.
 Fig. 5. HEMIASTER OLDHAMI, sp. nov., abactinal view ; natural size.
 Fig. 5A. " " " ambulacra and fasciole ; enlarged $\frac{3}{4}$.
 Fig. 6. HEMIASTER OLDHAMI, sp. nov., actinal view ; natural size.
 Fig. 7. " " " ornamentation ; enlarged.

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Pl. VIII.



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PLATE IX.

- Fig. 1. OSTREA ACUTIROSTRIS, Nilsson, left valve.
- Fig. 1a. " " " right valve.
- Fig. 1b. " " " posterior side.
- Fig. 2. OSTREA (ALECTRYONIA) PECTINATA, Lamarck, left valve.
- Fig. 3. OSTREA (ALECTRYONIA) PECTINATA, Lamarck, left valve.
- Fig. 3a. " " " " " posterior margin.
- Fig. 4. OSTREA (ALECTRYONIA) UNGULATA, Schlottheim, left valve.
- Fig. 4a. " " " " right valve.
- Fig. 4b. " " " " anterior side.
- Fig. 5. OSTREA (ALECTRYONIA) UNGULATA, Schlottheim, right valve.
- Fig. 6. EXOGYRA PYRENAICA, Leymerie, left valve.
- Fig. 6a. " " " right valve.
- Fig. 6b. " " " anterior side.
- Fig. 7. HINNITES (?) FOLIACEUS, sp. nov., right (?) valve.
- Fig. 8. HINNITES (?) FOLIACEUS, sp. nov., right (?) valve.
- Fig. 9. OSTREA ACUTIROSTRIS, Nilsson, left valve.
- Fig. 9a. " " " right valve.

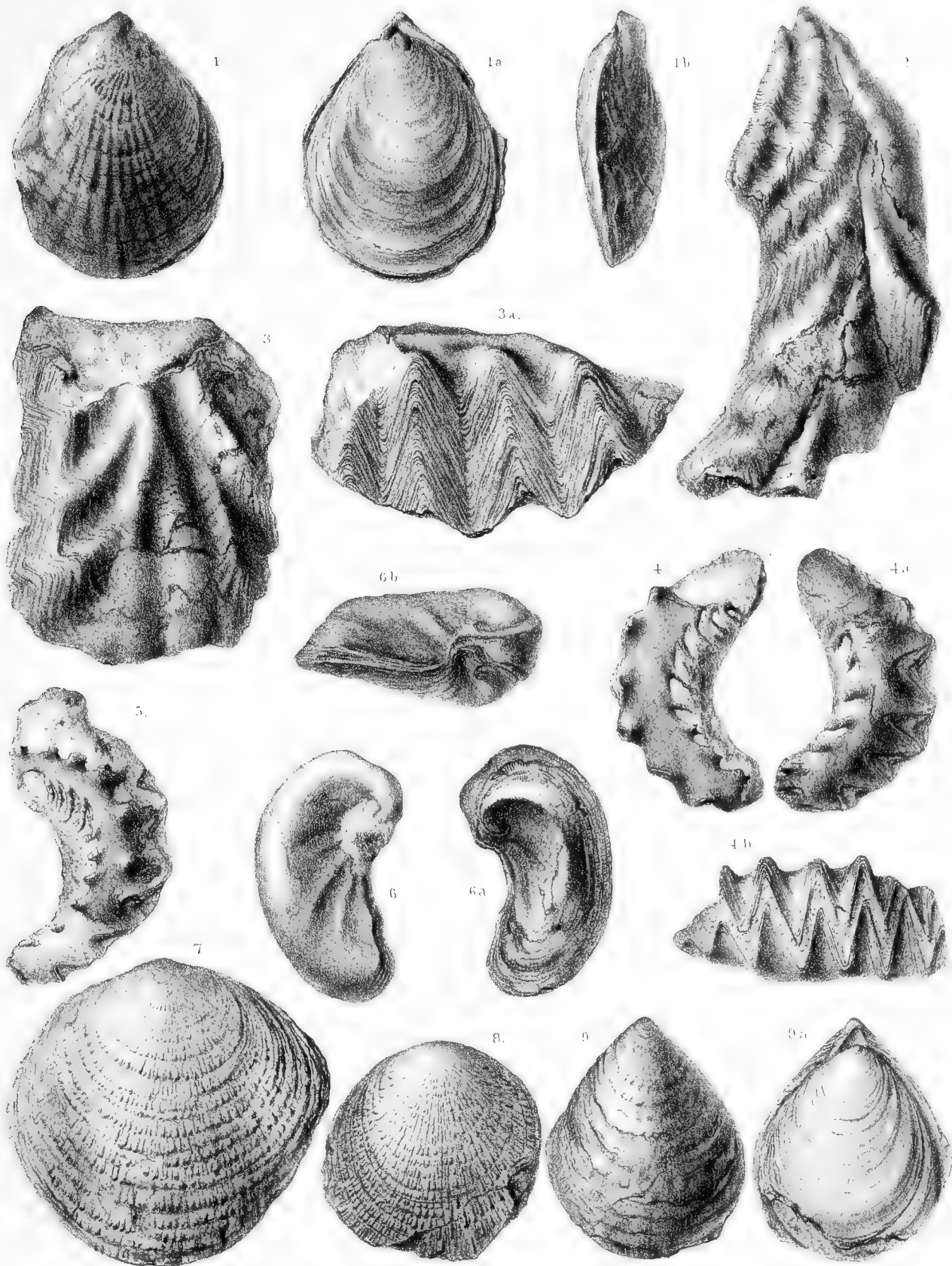


PLATE X.

- Fig. 1. GRYPHÆA VESICULARIS, Lamarck, left valve.
- Fig. 1*a*. " " " posterior side.
- Fig. 2. GRYPHÆA VESICULARIS, Lamarck, left valve.
- Fig. 2*a*. " " " "
- Fig. 2*b*. " " " " inside.
- Fig. 3. VOLA QUINQUEANGULARIS, sp. nov., right valve.
- Fig. 3*a*. " " " anterior side.
- Fig. 4. VOLA QUINQUEANGULARIS, sp. nov., right valve.
- Fig. 4*a*. " " " ornamentation ; enlarged.
- Fig. 5. MODIOLA SP.

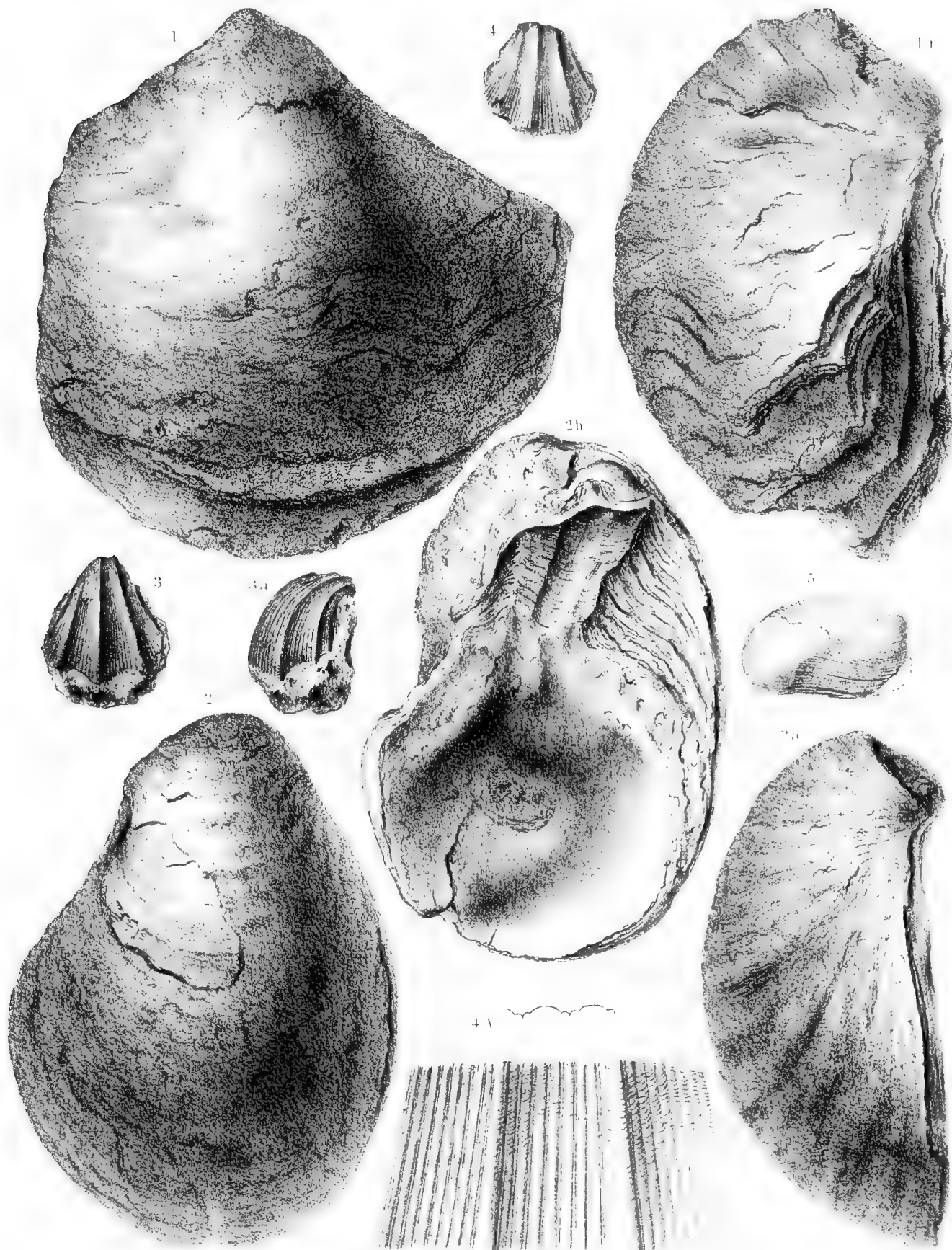
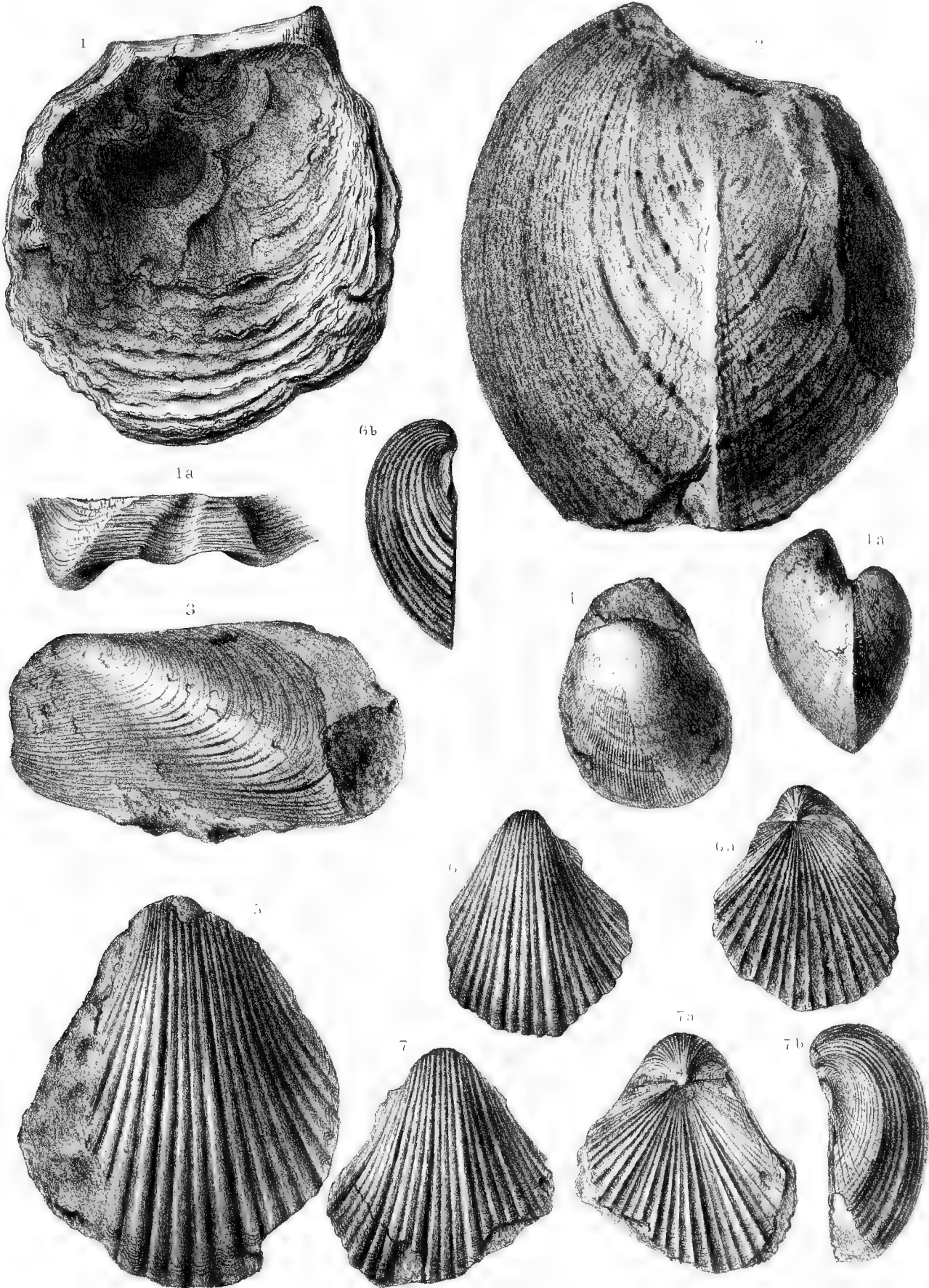


PLATE XI.

- Fig. 1. *GRYPHÆA VESICULARIS*, Lamarck, right valve.
 Fig. 1*a*. " " " " umbonal view.
 Fig. 2. *SPONDYLUS SANTONIENSIS*, d'Orbigny.
 Fig. 3. *MODIOLA VISHNU*, sp. nov.
 Fig. 4. *SPONDYLUS* sp. INDET., left valve.
 Fig. 4*a*. " " posterior side.
 Fig. 5. *VOLA QUADRICOSTATA*, Sowerby sp., right valve.
 Fig. 6. *VOLA QUADRICOSTATA*, Sowerby sp., right valve.
 Fig. 6*a*. " " " left valve.
 Fig. 6*b*. " " " anterior side.
 Fig. 7. *VOLA QUADRICOSTATA*, Sowerby sp., right valve.
 Fig. 7*a*. " " " left valve.
 Fig. 7*b*. " " " posterior side.



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PLATE XII.

- Fig. 1. PECTEN (CHLAMYS) DUJARDINI, Roemer.
 Fig. 1A. " " " " ornamentation; enlarged.
 Fig. 2. CARDITA (VENERICARDIA) BEAUMONTI, d'Arch and Haime, *var.* BALUCHISTANENS
 Noetl.
 Fig. 2a. " " " " "
 Fig. 3. CARDITA (VENERICARDIA) SUBCOMPLANATA, d'Arch and Haime.
 Fig. 3A. " " " " " ornamentation; enlarged.
 Fig. 4. CARDIUM HARNAIENSE, sp. nov.
 Fig. 4A. " " " ornamentation; enlarged.
 Fig. 5. CARDIUM LORALAIENSE, sp. nov.
 Fig. 5a. " " " posterior side.
 Fig. 5A. " " " ornamentation; enlarged.
 Fig. 6. CYPRINA MAZARIANA, sp. nov.
 Fig. 6a. " " " anterior side.
 Fig. 6b. " " " umbonal view.
 Fig. 7. CYPRINA DESENSIS, sp. nov.
 Fig. 7a. " " " anterior side.
 Fig. 7b. " " " umbonal view.
 Fig. 8. ROUDAIRIA CRASSOPPLICATA, sp. nov.
 Fig. 8a. " " " anterior side.
 Fig. 9. CHAMA CALLOSA, sp. nov.
 Fig. 9a. " " " posterior side.
 Fig. 10. CHAMA CALLOSA, sp. nov.
 Fig. 10a. " " " right (?) valve.
 Fig. 10b. " " " posterior side.

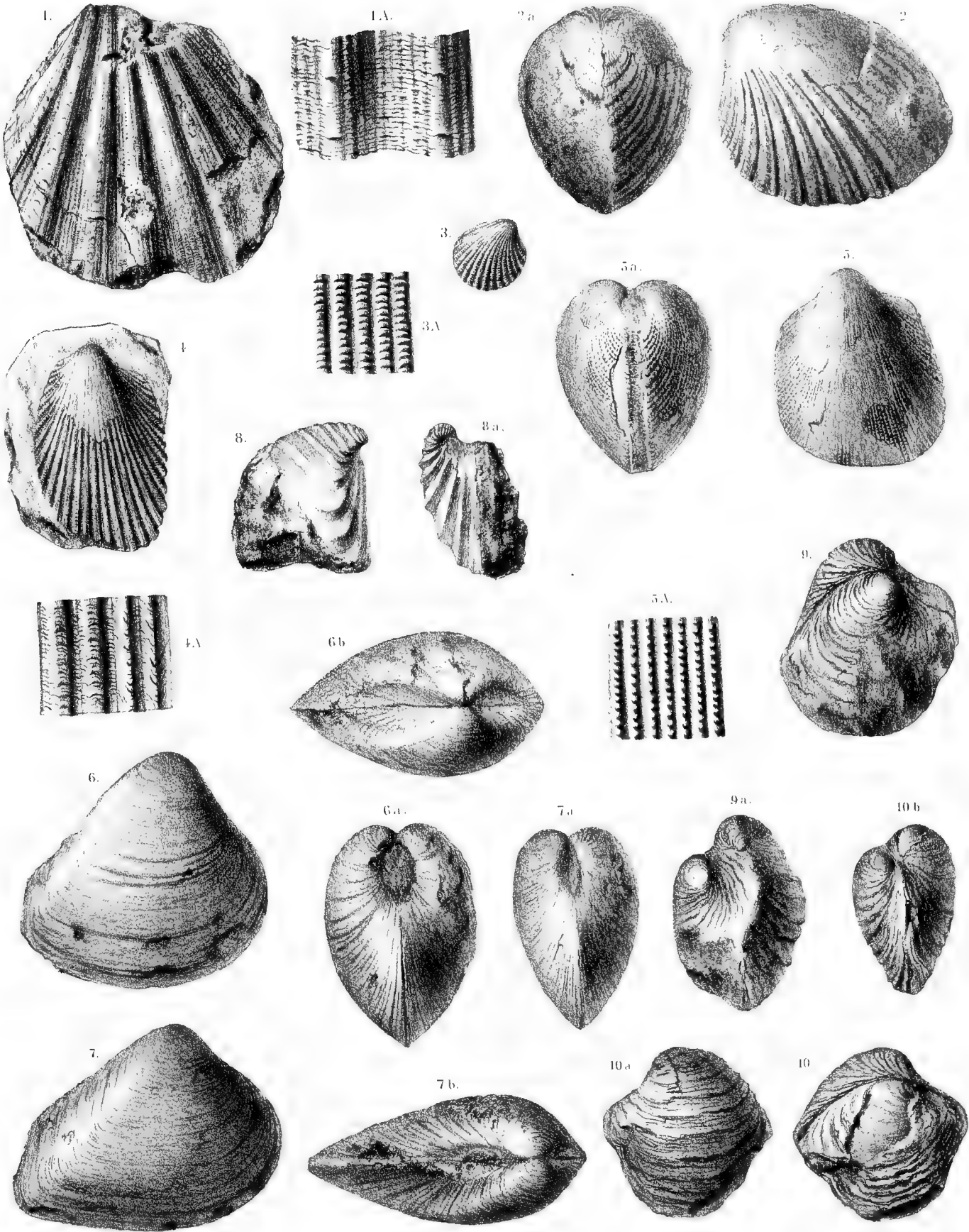


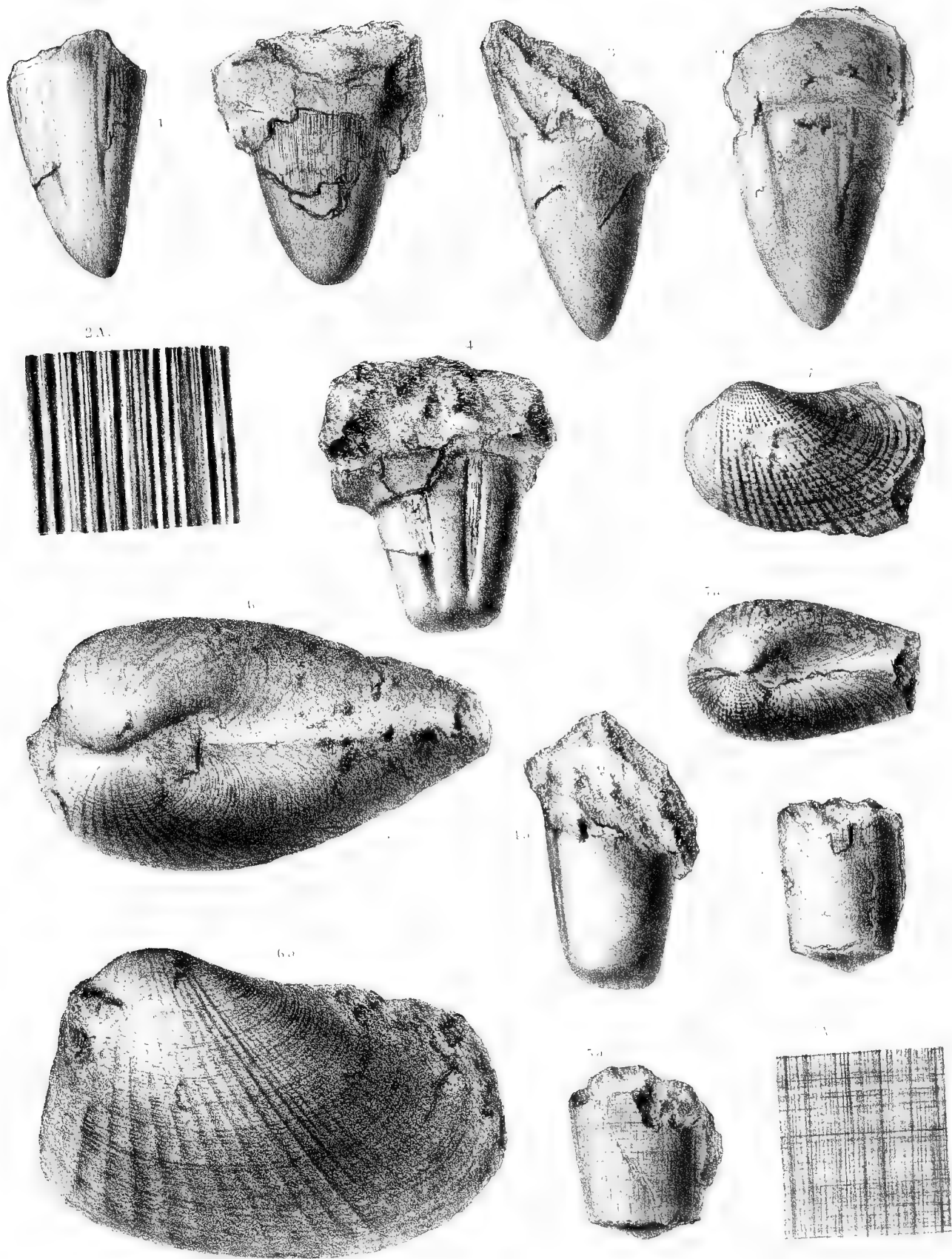
FIG. 12. Fossils.

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PLATE XIII.

- Fig. 1. RADIOLITES MUSCHKETTOFFI, sp. nov.
 Fig. 2. " " "
 Fig. 2A. " " ornamentation; enlarged.
 Fig. 3. RADIOLITES MUSCHKETTOFFI.
 Fig. 3a. " " "
 Fig. 4. RADIOLITES SUBDILATATA, Romanowski sp.
 Fig. 4a. " " "
 Fig. 5. RADIOLITES SUBDILATATA, Romanowski.
 Fig. 5a. " " "
 Fig. 5A. " " ornamentation; enlarged.
 Fig. 6. PHOLADOMYA TIGRIS, sp. nov., umbonal view.
 Fig. 6a. " " "
 Fig. 7. PHOLADOMYA INDICA, sp. nov.
 Fig. 7a. " " " umbonal view.

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PLATE XIV.

- Fig. 1. *TROCHUS LARTETIANUS*, Leymerie, back.
Fig. 1a. " " " base.
Fig. 2. *TROCHUS LARTETIANUS*, Leymerie.
Fig. 2A. " " " ornamentation ; enlarged.
Fig. 3. *NERITA PONTICA*, d'Archiac, back.
Fig. 3a. " " " apex.
Fig. 3A. " " " ornamentation ; enlarged.
Fig. 4. *NERITA PONTICA*, d'Archiac, back.
Fig. 4a. " " " apex.
Fig. 4b. " " " base.
Fig. 5. *NERITA D'ARCHIACI*, sp. nov., back.
Fig. 5a. " " " apex.
Fig. 5b. " " " front.
Fig. 6. *NERITA D'ARCHIACI*, sp. nov., back.
Fig. 6a. " " " apex.
Fig. 7. *NERITA D'ARCHIACI*, sp. nov., back.
Fig. 7a. " " " front.
Fig. 7b. " " " apex.
Fig. 7A. " " " ornamentation ; enlarged.
Fig. 8. *TURITELLA*, sp. 2, back.
Fig. 9. *TURITELLA*, sp. 1, back.
Fig. 10. *TURITELLA*, *QUINQUECOSTATA*, sp. nov.
Fig. 10A. " " " ornamentation ; enlarged.
Fig. 11. *CALYPTREÆA*, sp., side.
Fig. 11a. " " apex.
Fig. 12. *NERINEA QUETTENSIS*, sp. nov.
Fig. 12a. " " "
Fig. 13. *NERINEA QUETTENSIS*, sp. nov.
Fig. 14. *CERITHIUM* (?) sp.
Fig. 14a. " "
Fig. 15. *CERITHIUM* (?) sp.
Fig. 15a. " " ornamentation ; enlarged.

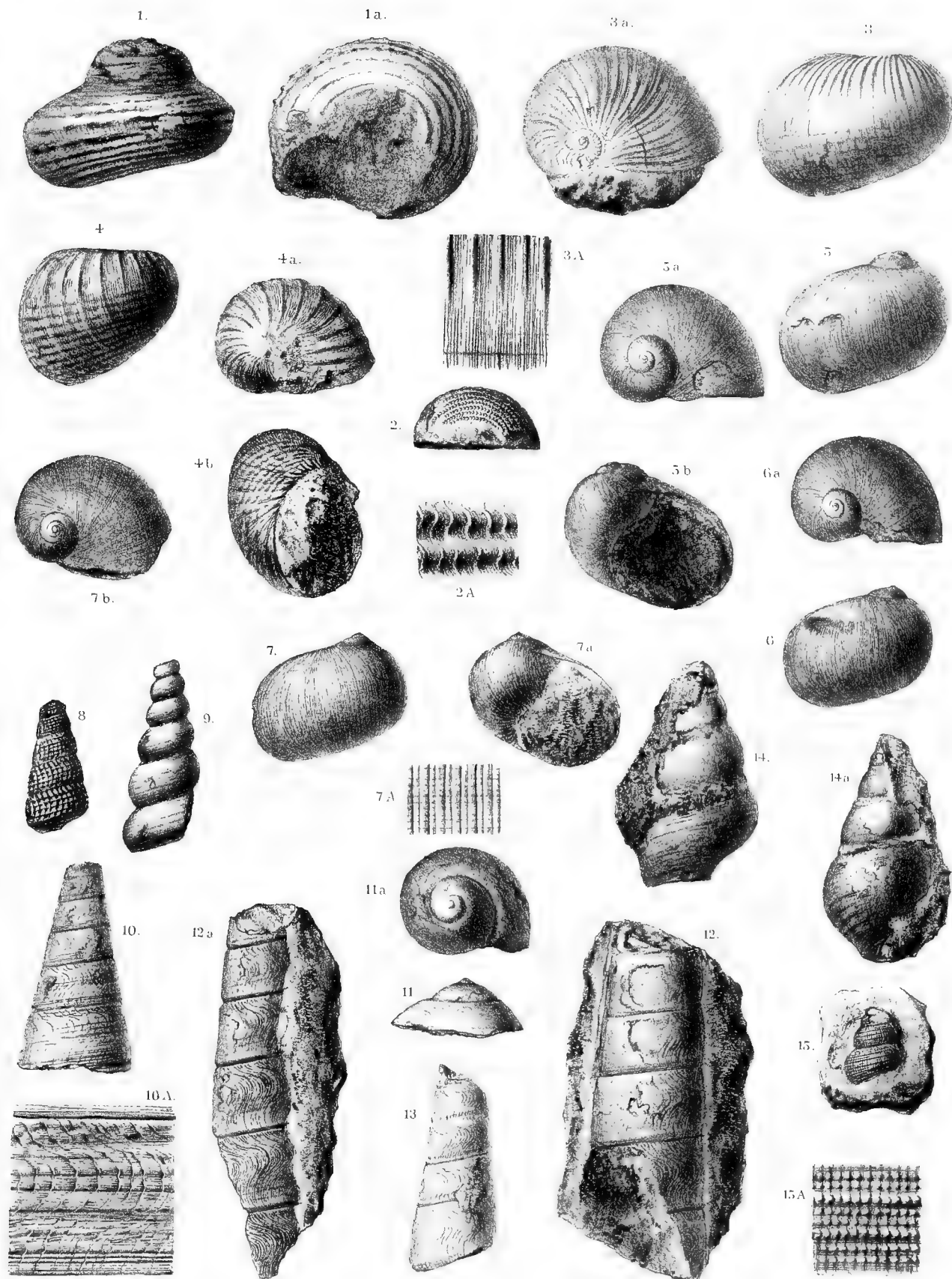
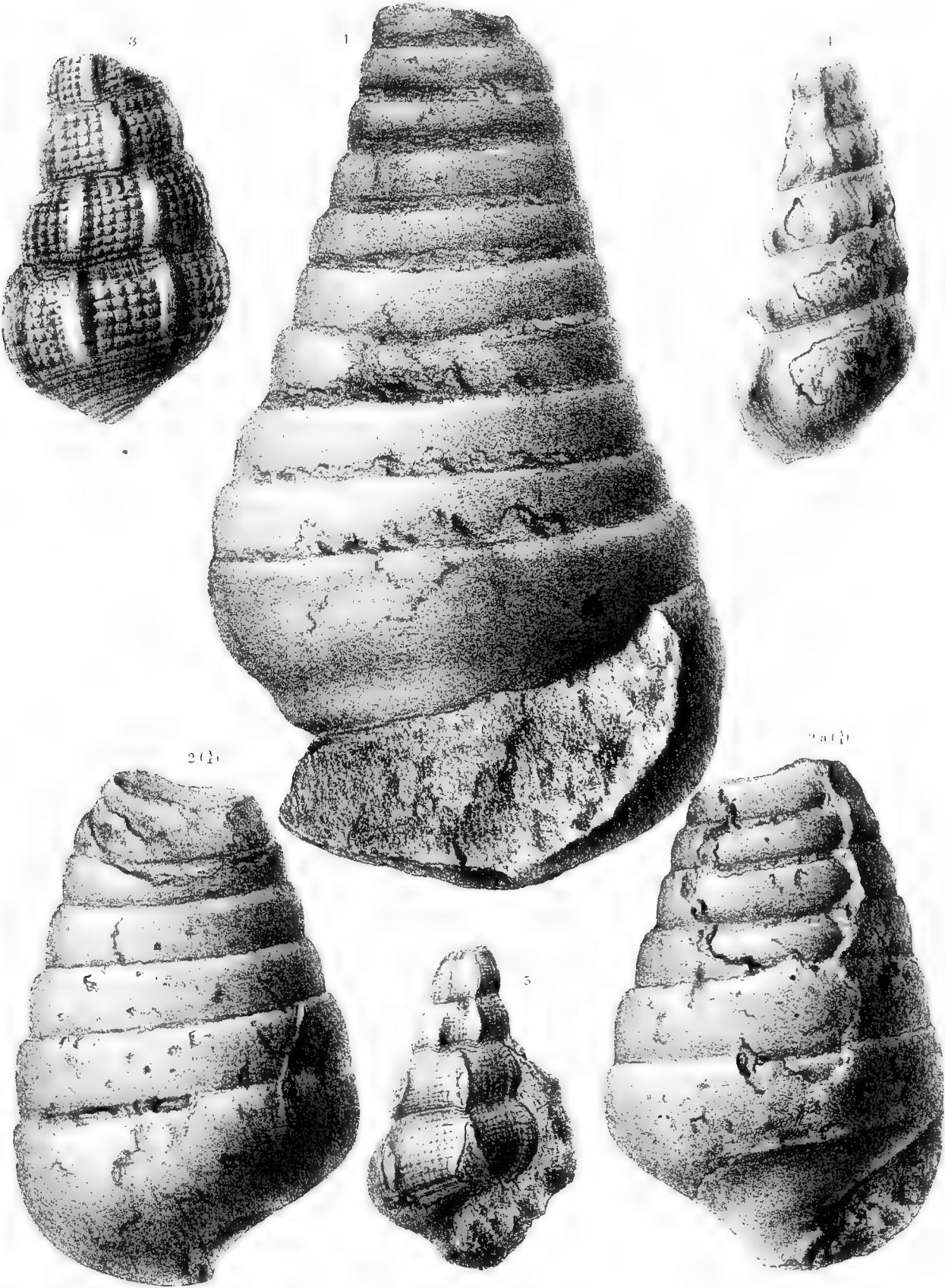


PLATE XV.

- Fig. 1. NERINEA GANESHA, sp. nov., front, cast.
Fig. 2. NERINEA GANESHA, sp. nov., back ; with partly preserved shell, reduced to $\frac{2}{3}$ size.
Fig. 2a. " " "
Fig. 3. CERITHIUM VISHNU, sp. nov., back.
Fig. 4. CERITHIUM BUDDHA, sp. nov., back.
Fig. 5. CERITHIUM BUDDHA, sp. nov., front.



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PLATE XVI.

- Fig. 1. *NERINEA GANESHA*, sp. nov., cast, back.
- Fig. 1a. " " " apex, to show spiral folds.
- Fig. 2. *NERINEA GANESHA*, sp. nov., part of whorls, cast.
- Fig. 2a. " " " cross section to show internal folds.
- Fig. 3. *PUGNELLUS CRASSICOSTATUS*, sp. nov., cast, back.
- Fig. 3a. " " " " front.
- Fig. 4. *PUGNELLUS CRASSICOSTATUS*, sp. nov., shell, back.
- Fig. 4a. " " " " side.
- Fig. 5. *PUGNELLUS DIGITATUS*, sp. nov., back.
- Fig. 5a. " " " " front.
- Fig. 6. *PUGNELLUS DIGITATUS*, sp. nov., back; shell partly preserved.
- Fig. 6a. " " " " side.
- Fig. 7. *PUGNELLUS DIGITATUS*, sp. nov., cast, back.
- Fig. 8. *VOLUTILITHES DUBIA*, sp. nov., back.
- Fig. 8a. " " " " front.
- Fig. 9. *VOLUTILITHES LATISEPTA*, Stoliczka, back.
- Fig. 10. *VOLUTILITHES LATISEPTA*, Stoliczka, back.
- Fig. 11. *CONUS* sp., side.
- Fig. 11a. " " apex.
- Fig. 12. *STRIGATELLA* sp., back.
- Fig. 12a. " " front.
- Fig. 13. *VOLUTA PSEUDOCOSTATA*, sp. nov., front.

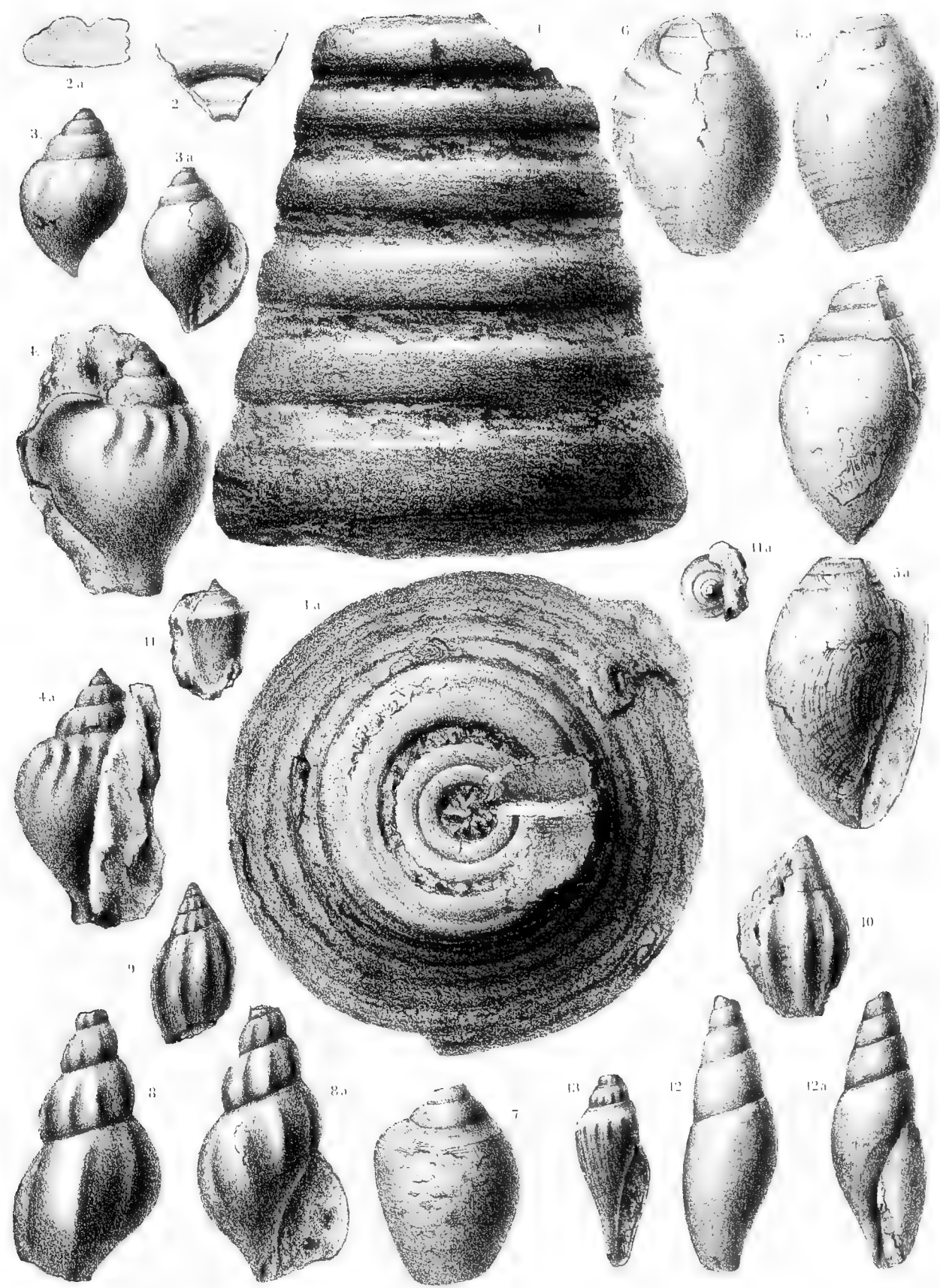


PLATE XVII.

- Fig. 1. PUGNELUS GIGANTEUS, sp. nov., back.
 Fig. 1a. " " " front.
 Fig. 2. VOLUTOMORPHA sp., back.
 Fig. 3. OVULA EXPANSA, d'Archiac and Haime, back.
 Fig. 3a. " " " front.
 Fig. 3b. " " " apex.
 Fig. 3c. " " " anterior.
 Fig. 4. OVULA sp., front.

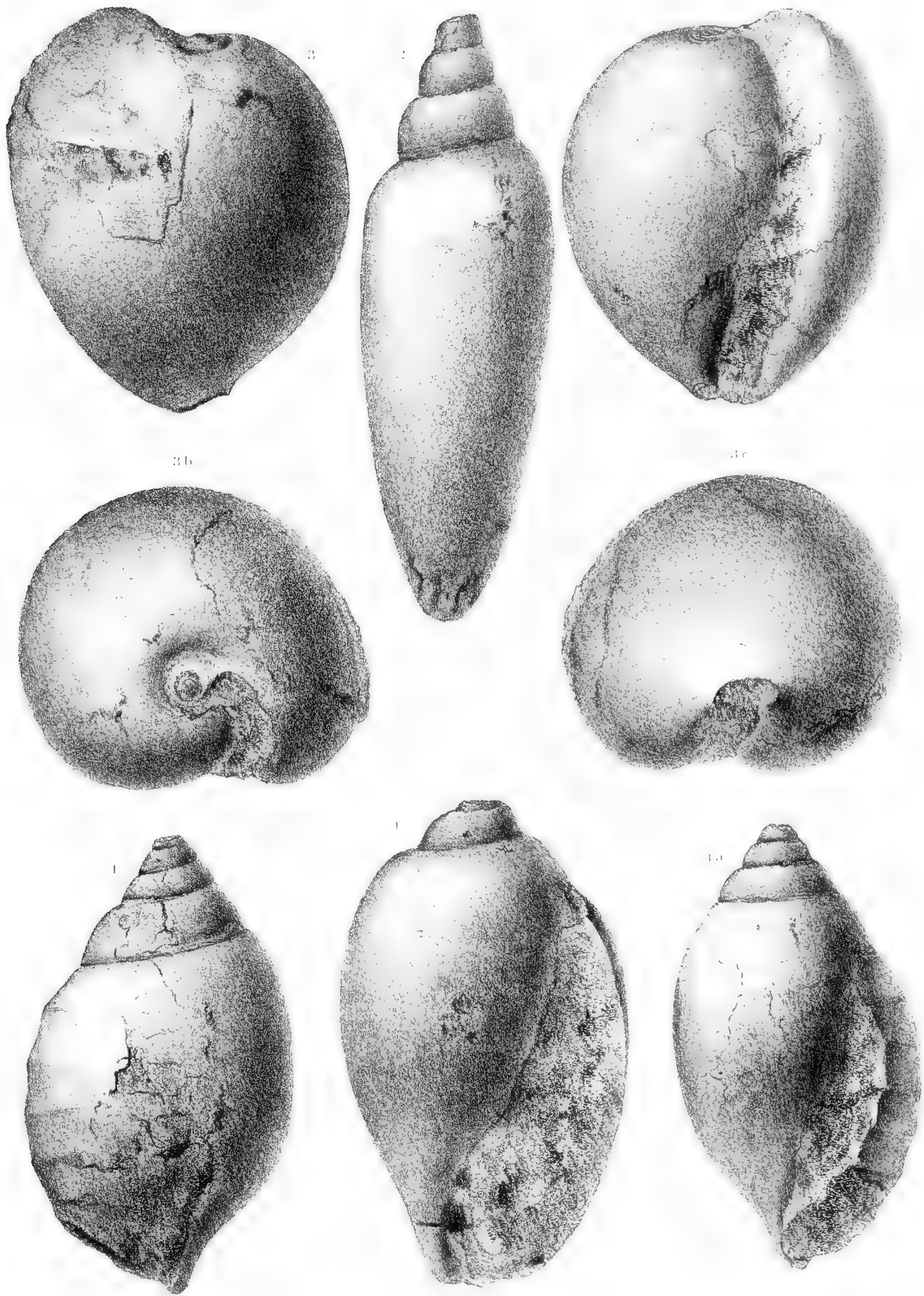


PLATE XVIII.

| | | | | |
|----------|-------|-------------------|----------------------|-----------|
| Fig. 1. | Ovula | Baluchistanensis, | sp. nov., | back. |
| Fig. 1a. | " | " | " | front. |
| Fig. 1b. | " | " | " | apex. |
| Fig. 2. | Ovula | expansa, | d'Archiac and Haime, | back. |
| Fig. 2a. | " | " | " | front. |
| Fig. 2b. | " | " | " | apex. |
| Fig. 3. | Ovula | expansa, | d'Archiac and Haime, | back. |
| Fig. 3a. | " | " | " | front. |
| Fig. 3b. | " | " | " | apex. |
| Fig. 3c. | " | " | " | anterior. |
| Fig. 4. | Ovula | expansa, | d'Archiac and Haime, | back. |
| Fig. 4a. | " | " | " | front. |
| Fig. 4b. | " | " | " | apex. |
| Fig. 4c. | " | " | " | anterior. |

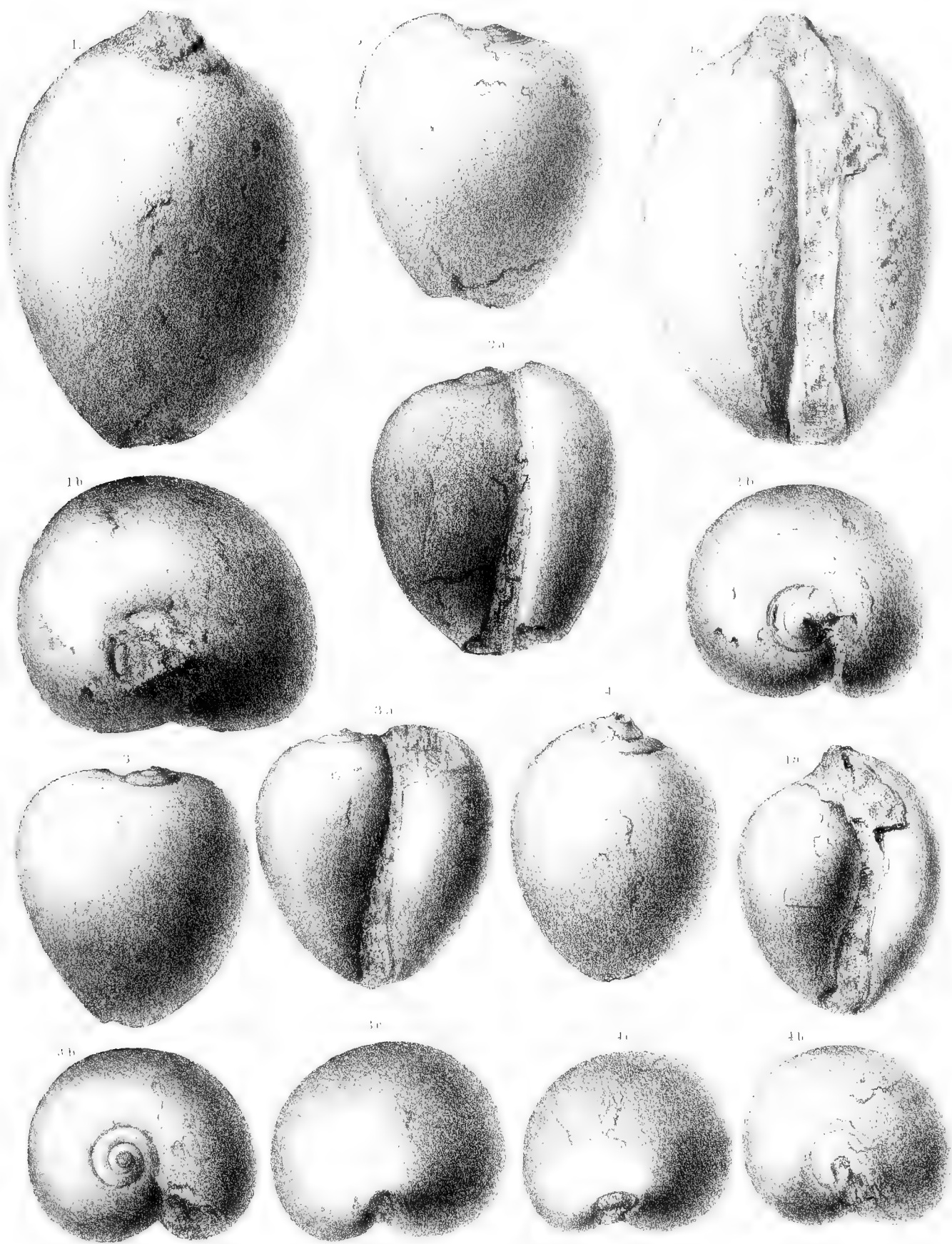


PLATE XIX.

- Fig. 1. NAUTILUS SUBLAEVIGATUS, d'Orbigny, side view.
Fig. 1*a*. " " " "
Fig. 2. NAUTILUS SUBLAEVIGATUS, d'Orbigny, side view.
Fig. 2*a*. " " " front view.

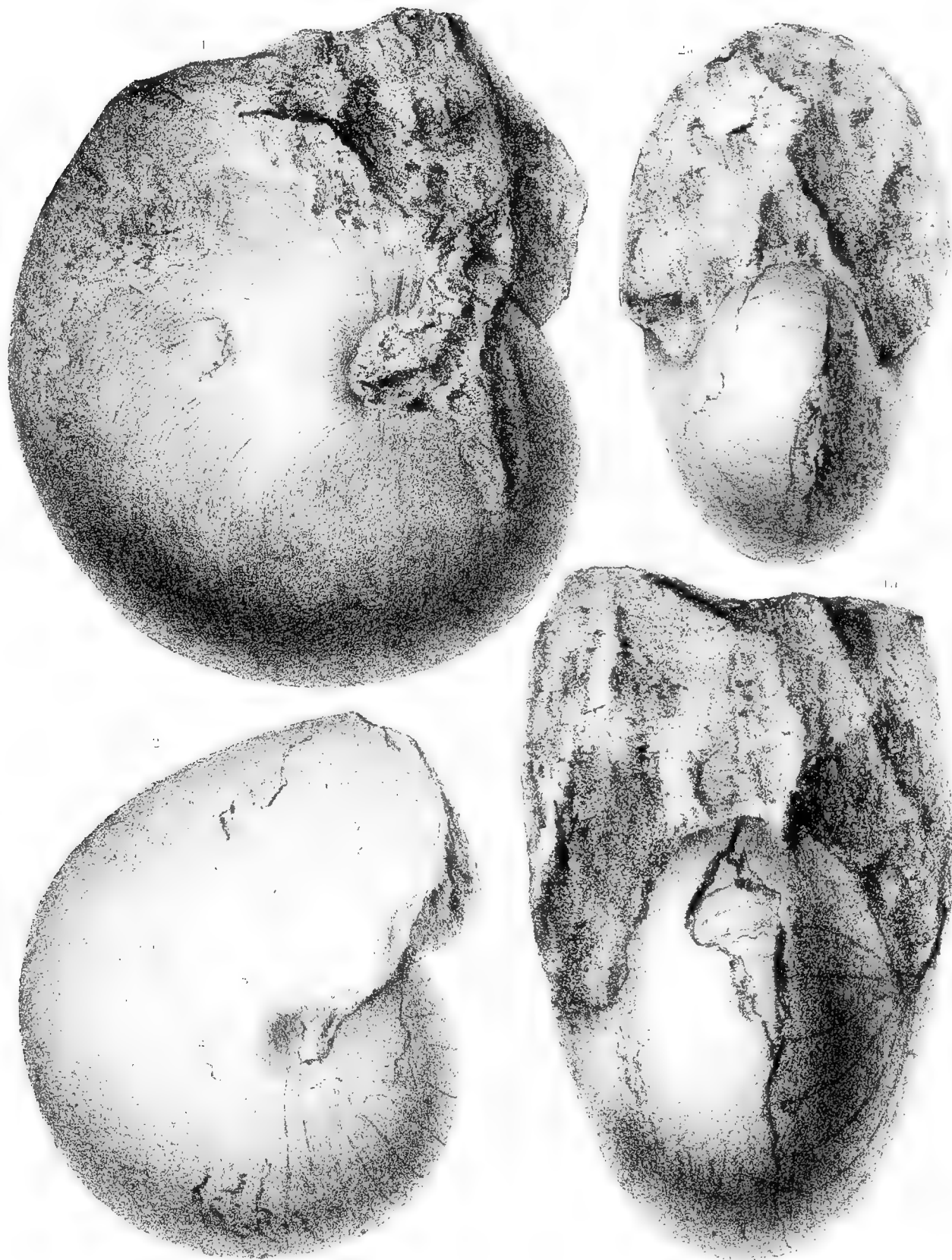


PLATE XX.

- Fig. 1. NAUTILUS SUBLAEVIGATUS, d'Orbigny, side view.
Fig. 1a. " " " ventral side.
Fig. 2. NAUTILUS SUBLAEVIGATUS, d'Orbigny, side view.
Fig. 2a. " " " ventral view.
Fig. 2b. " " " front view.
Fig. 3. NAUTILUS SUBPLEURIAUSIANUS, d'Archiac and Haime, side view.
Fig. 3a. " " " " frontal view

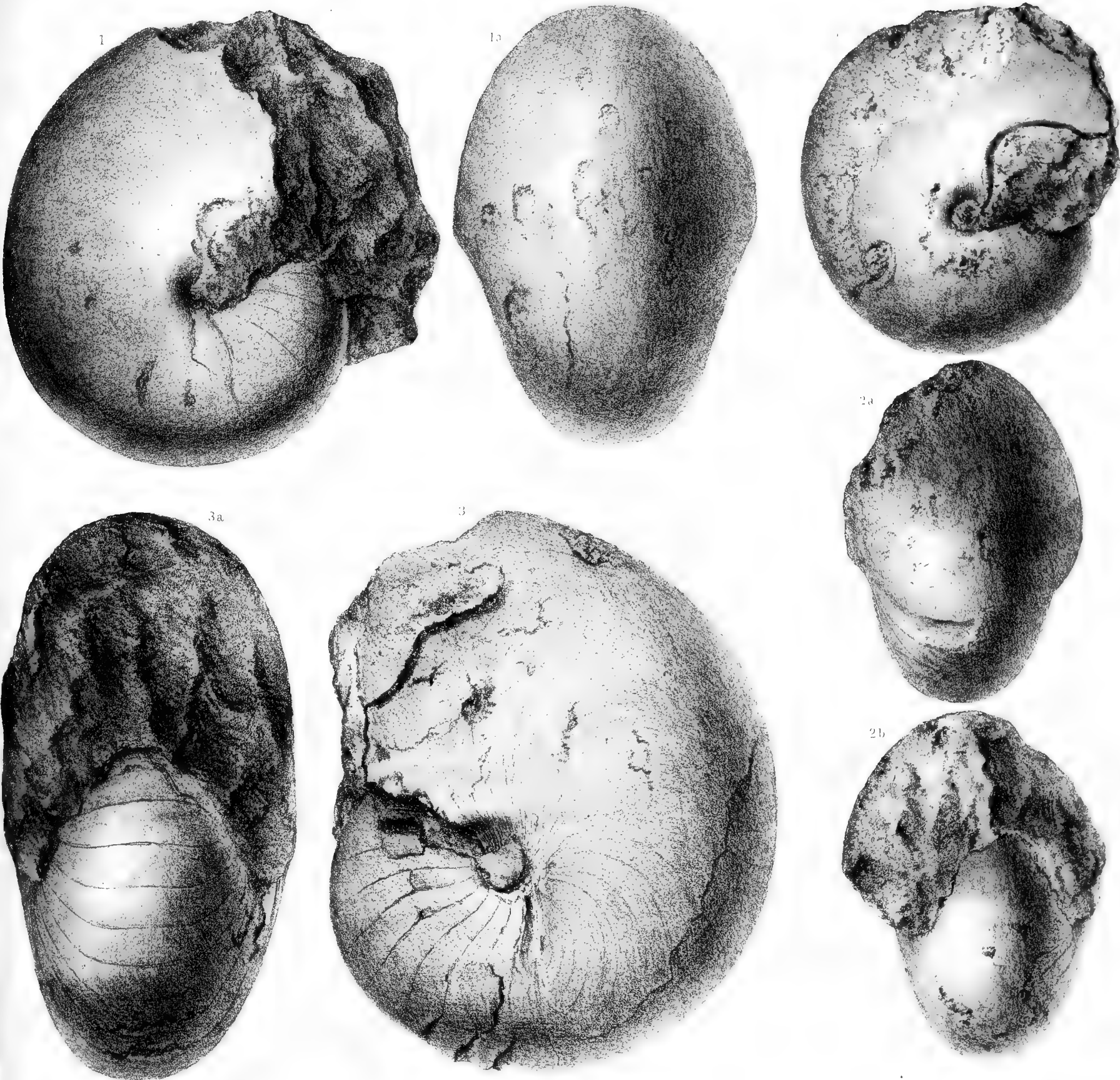


PLATE XXI.

- Fig. 1. NAUTILUS SUBFLEURIAUSIANUS, d'Archiac and Haime, inner whorls.
 Fig. 1a. " " " " " "
 Fig. 2. INDOCERAS BALUCHISTANENSIS, sp. nov., side view.
 Fig. 2a. " " " siphonal view.
 Fig. 2A. " " " suture line.
 Fig. 3. SPHENODISCUS ACUTODORSATUS, sp. nov., side view.
 Fig. 3a. " " " front view.
 Fig. 3A. " " " suture line.

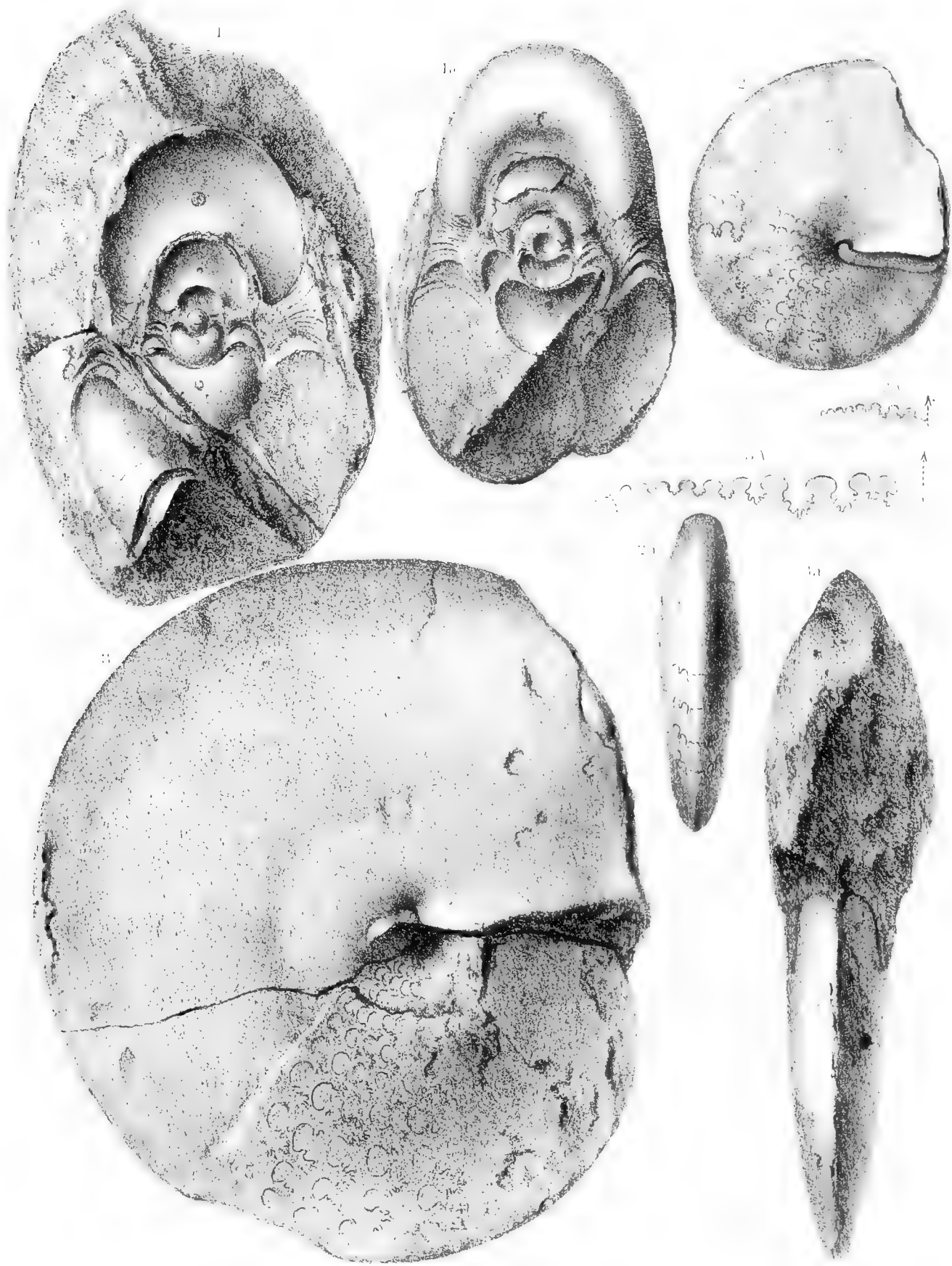


PLATE XXII.

- Fig. 1. *INDOCERAS BALUCHISTANENSIS*, sp. nov., side view.
Fig. 1*a*. „ „ „ front view.
Fig. 1*b*. „ „ „ siphonal view.
Fig. 2. *INDOCERAS BALUCHISTANENSIS*, sp. nov., side view.
Fig. 2*a*. „ „ „ front view.
Fig. 2*b*. „ „ „ siphonal view.
Fig. 3. *INDOCERAS BALUCHISTANENSIS*, sp. nov., side view.
Fig. 3*a*. „ „ „ front view.
Fig. 4. *RANINA GRIESBACHI*, sp. nov.

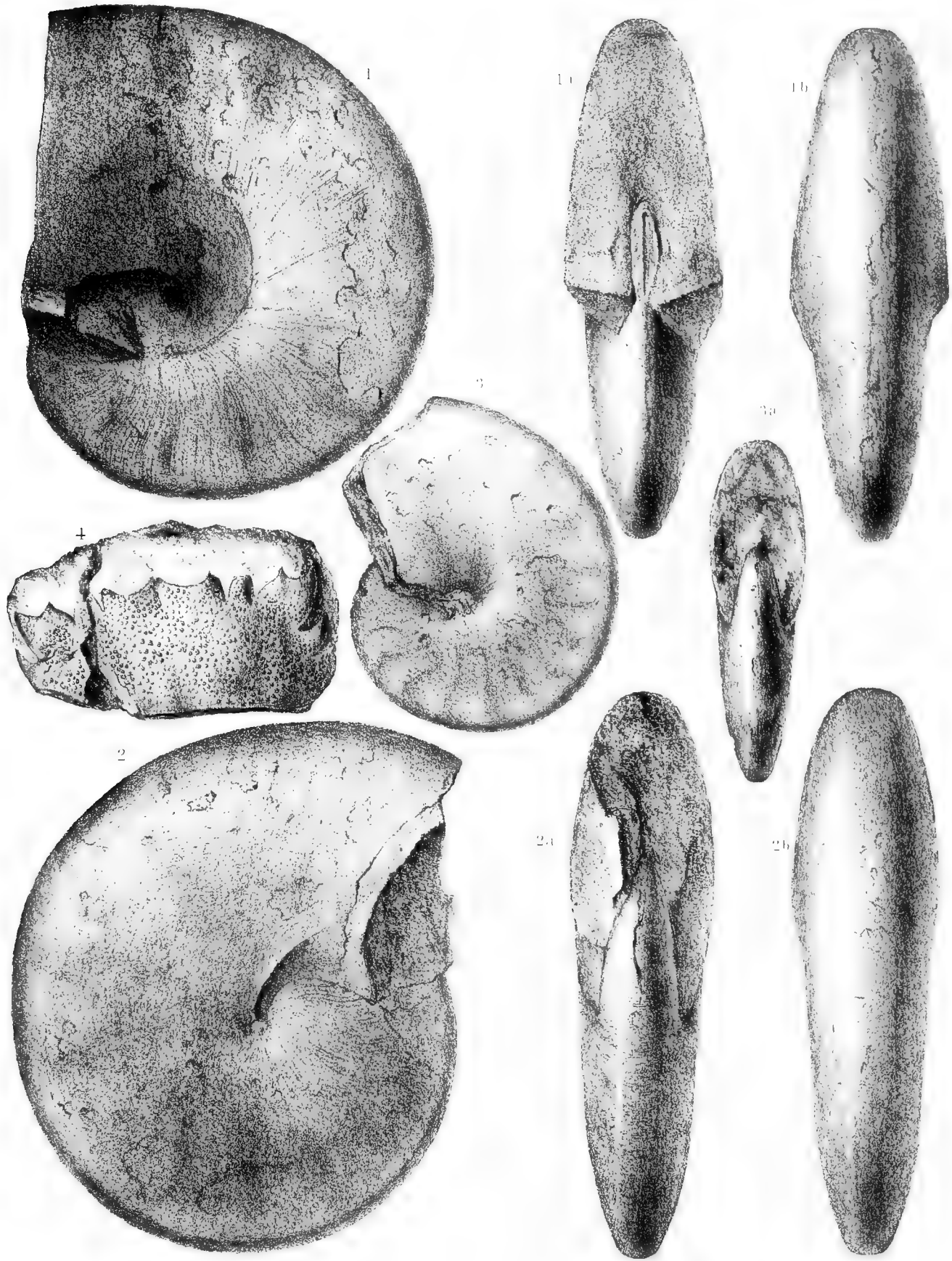
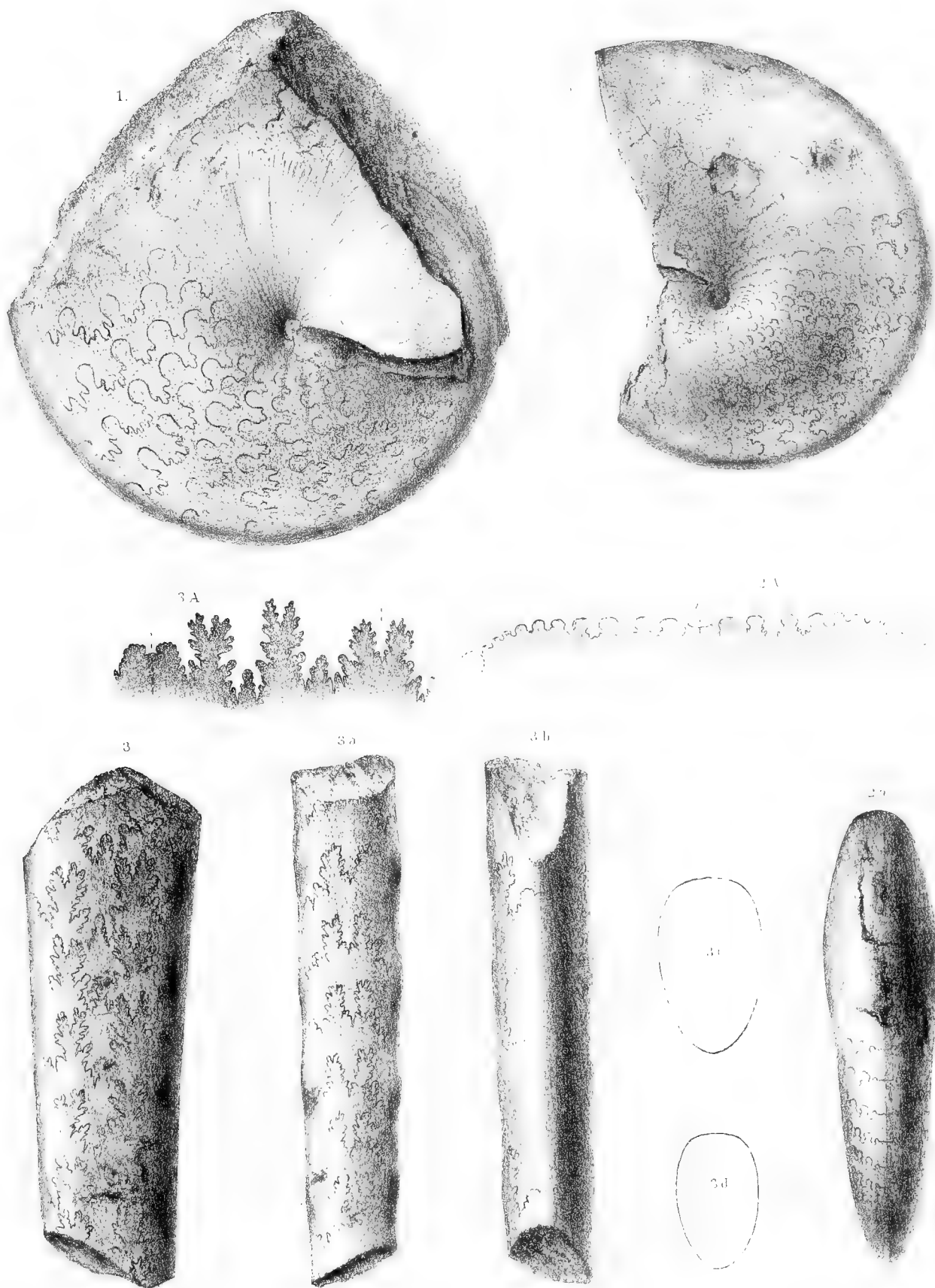


PLATE XXIII.

- Fig. 1. INDOCERAS BALUCHISTANENSIS, sp. nov., side view.
 Fig. 2. INDOCERAS BALUCHISTANENSIS, sp. nov., side view.
 Fig. 2a. " " " siphonal side.
 Fig. 2A. " " " suture line; enlarged.
 Fig. 3. BACULITES BINODOSUS, sp. nov., side view.
 Fig. 3a. " " " antisiphonal side.
 Fig. 3b. " " " siphonal side.
 Fig. 3c. " " " cross section at the upper end.
 Fig. 3d. " " " " " lower end.
 Fig. 3A. " " " suture line.



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